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Underground Mine Drainage Control Snowy Creek-Laurel Run, West Virginia Feasibility Study

West Virginia Dept of Natural Resources, Charleston

Prepared for

Industrial Environmental Research Lab, Cincinnati, Ohio

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16. ABSTRACT

A study was conducted at the Snowy Creek - Laurel Run basin near Terra Alta, West Virginia, to determine the feasibility of demonstrating mine drainage control by known abatement techniques in abandoned coal mine areas having shallow overburden.

The basin contains two abandoned mining complexes that have extensively deep-mined the Lower Kittanning coal found in the Mount Carmel syncline. Associated mine pool discharges are responsible for 90 percent of AMD pollution in Snowy Creek which discharges into the Youghiogheny River (now being considered as a part of the National Wild and Scenic Rivers System). Only one-third of the Snowy Creek - Laurel Run basin is affected by AMD.

Additional inundation and stabilization of the mine pools were judged necessary to reduce the AMD pollution. The recommended approach was to utilize continuous clay core dams, a mine pool level control lake and movable wall bulkhead seals to increase the size of the mine pools. It was felt that this abatement approach was feasible.

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UNDERGROUND MINE DRAINAGE CONTROL
SNOWY CREEK-LAUREL RUN, WEST VIRGINIA
FEASIBILITY STUDY

by

Baker-Wibberley & Associates, Inc.
Hagerstown, Maryland 21740

Contract No. S-802644

Project Officer

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Rivesville, West Virginia 26588

This study was conducted in cooperation with
West Virginia Department of Natural Resources
Charleston, West Virginia 25311

INDUSTRIAL ENVIRONMENTAL RESEARCH CENTER
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
CINCINNATI, OHIO 45268

DISCLAIMER

This report has been reviewed by the Industrial Environmental Research Laboratory - Cincinnati (IERL-Ci), U.S. Environmental Protection Agency, and approved for publication. Approval does not signify that the contents necessarily reflect the views and policies of the U.S. Environmental Protection Agency; nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

FOREWORD

When energy and material resources are extracted, processed, converted, and used, the related pollutional impacts on our environment and even on our health often require that new and increasingly more efficient pollution control methods be used. The Industrial Environmental Research Laboratory - Cincinnati (IERL-Ci) assists in developing and demonstrating new and improved methodologies that will meet these needs both efficiently and economically.

The eastern United States has significant acid mine drainage problems as a result of underground coal mining. A major portion of these mines are no longer active. Techniques for controlling this pollution are limited, because of technical problems and cost. This study was undertaken to evaluate the feasibility of several innovative abatement methods. The Snowy Creek-Laurel Run basin, West Virginia, was selected for the study. The results of the study were that a lake to control mine pool level, a continuous clay core dam, and marble wall bulkhead seals were best suited for this watershed.

The results of this study should be of interest to those persons planning abatement programs for abandoned underground mines and to 208 planning agencies. For further information contact the Resource Extraction and Handling Division.

David G. Stephan
Director
Industrial Environmental Research Laboratory
Cincinnati

ABSTRACT

A study was conducted at the Snowy Creek - Laurel Run basin near Terra Alta, West Virginia, to determine the feasibility of demonstrating mine drainage control by known abatement techniques in abandoned coal mine areas having shallow overburden.

The basin contains two abandoned mining complexes that have extensively deep-mined the Lower Kittanning coal found in the Mount Carmel syncline. Associated mine pool discharges are responsible for 90 percent of AMD pollution in Snowy Creek which discharges into the Youghiogheny River (now being considered as a part of the National Wild and Scenic Rivers System). Only one-third of the Snowy Creek - Laurel Run basin is affected by AMD.

Additional inundation and stabilization of the mine pools were judged necessary to reduce the AMD pollution. The recommended approach was to utilize continuous clay core dams, a mine pool level control lake and movable wall bulkhead seals to increase the size of the mine pools. It was felt that this abatement approach was feasible.

This report was submitted in fulfillment of Contract No. 802644 by Baker-Wibberley & Associates, Inc., Hagerstown, Maryland, for the West Virginia Department of Natural Resources under the sponsorship of the U.S. Environmental Protection Agency. This report covers the period April 1, 1975 to March 1, 1977.

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CONVERSION TABLE

Divide (Metric Units)	by (Conversion)	To Obtain (English Units)
cubic meters	1.308	cubic yards
cubic meters/minute	1.700	cubic feet/second
degrees Celsius	(C x 1.8) +32*	degrees Fahrenheit
hectares	.405	acres
kilograms	.4536	pounds
kilometers	1.609	miles
meters	.9144	yards
metric tons	.907	short tons
millimeters	25.4	inches

* Actual Conversion, not a division

This report was prepared during the period of national conversion to the metric system. Wherever practical, metric units are used. A few concessions were necessary for ease of readability. For example, elevations are quoted in feet in the absence of suitable metric topographic controls or mapping. Also, published tabulations or records are maintained in their quoted form.

ACKNOWLEDGEMENTS

Baker-Wibberley & Associates, Inc. wishes to acknowledge all and to express our appreciation to all who provided assistance during the completion of this project. Special gratitude is extended to:

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- U.S. Environmental Protection Agency; Robert B. Scott, Project Officer.
- West Virginia Department of Natural Resources; Don E. Caldwell, Project Director and Ben Greene, Edwin Deem, and JoAnn Irwin.
- Kray Coal Company, Crellin, Maryland; Stanley Ashby, Vice President.
- Grafton Coal Company, Clarksburg, West Virginia; Jim Roy.
- The project team, Richard G. Beegle, Project Manager; Michael M. Dreisbach, Project Coordinator; Richard C. Ely, Mining Engineer; and Edwin F. Koppe, Geologist.

SECTION 1

INTRODUCTION

The effects of abandoned mine drainage have been felt throughout Appalachia and West Virginia is no exception. Many areas of this State have been adversely affected by abandoned mine drainage. The Snowy Creek - Laurel Run basin was chosen as an excellent example that could be used as a demonstration project for determining methods with the best potential for abatement control designs. The demonstration of an abatement technique, once it has been proven effective, can serve as a model for future abatement technology under similar conditions.

This study has investigated in great detail existing pollution control laws affecting the basin, the physical environment (including the physiography and geology), present and past mining activities, water resources (including its climatology and hydrology), chemical analyses of the waters in the subject basin and the socio-economic environment found in the study basin. Investigations into these areas yielded a wealth of background information from which preliminary engineering of proposed abatement designs was developed.

The feasibility study is in Preston County, West Virginia. The Snowy Creek - Laurel Run basin (Figure 1) is situated on the Maryland - West Virginia border approximately 48.3 km (30 miles) southeast of Morgantown and south of the Pennsylvania - West Virginia border. The effects of mine drainage result from two major sections of the basin that have been extensively deep mined beginning in the early 1890's.

The Snowy Creek - Laurel Run basin is also a major headwater tributary draining into the Youghiogheny River. At present, the Upper Youghiogheny is being considered as a part of the National Wild and Scenic Rivers System as established by Congress in 1968 (PL 90-542). In this act Congress proclaimed that these scenic rivers, "shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations." Thus this basin study has a direct bearing on the "Scenic Rivers" classification for the Youghiogheny River.

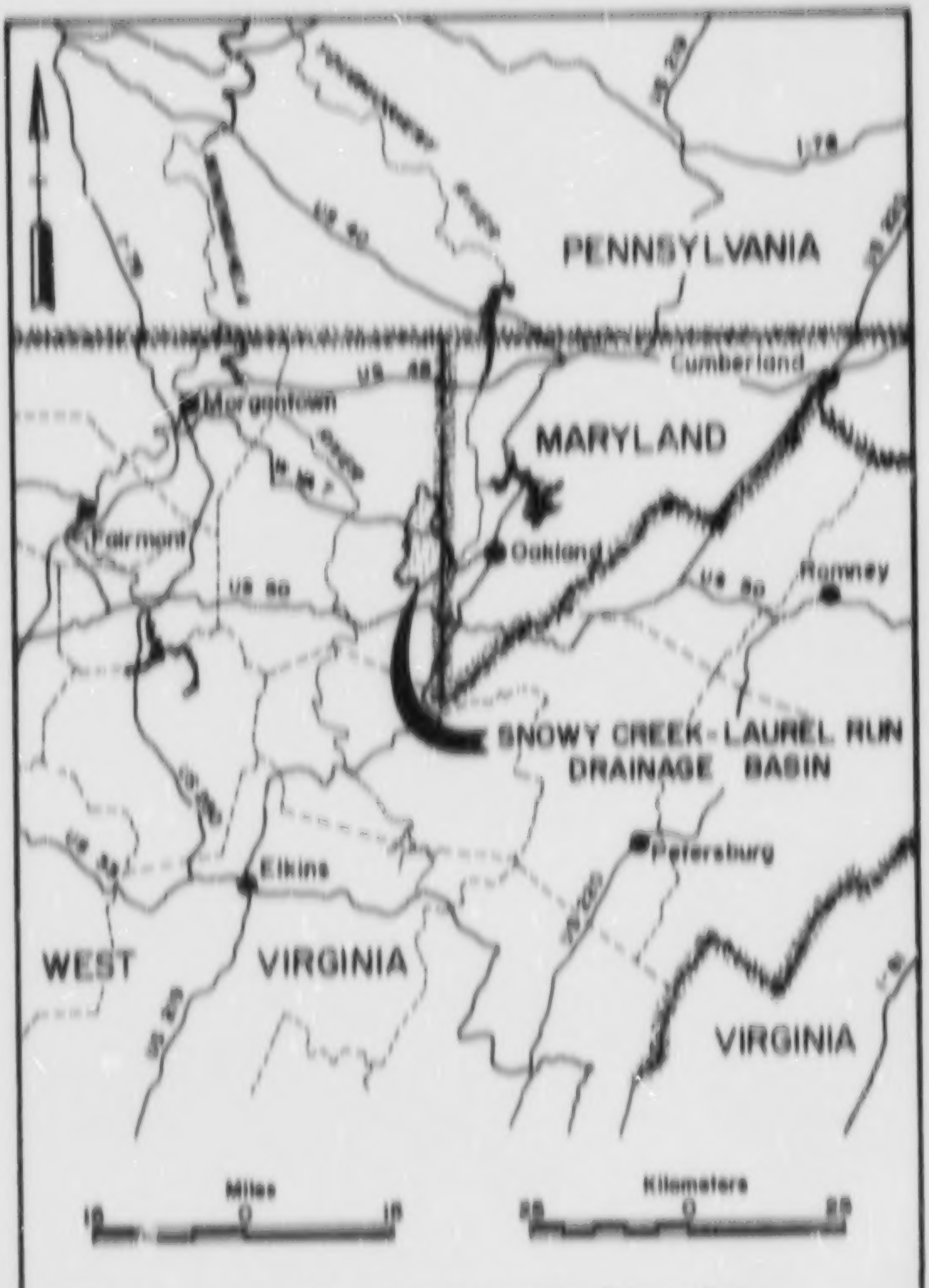

PENNSYLVANIA
MARYLAND
WEST
VIRGINIA
VIRGINIA
Cumberland
Morgantown
Fairmont
Oakland
Romney
Petersburg
Elkins
US 40
US 48
US 50
US 33
US 219
US 220
I-70
I-79
I-81
SNOWY CREEK-LAUREL RUN
DRAINAGE BASIN
Miles
15
0
15
Kilometers
25
0
25

Figure 1. Location of the Snowy Creek-Laurel Run Drainage Basin.

SECTION 2

CONCLUSIONS

1. This feasibility study proved that a demonstration project to abate AMD pollution in the Snowy Creek - Laurel Run basin is feasible. Utilizing a continuous clay core dam and a mine pool level control lake will abate abandoned mine drainage in areas of mining having a shallow overburden.

2. Two major sources of acid mine drainage are found in the Snowy Creek - Laurel Run basin-the Banner Mine and the Lima Mine. The Lima Mine pool is controlled by an outfall at an elevation of 743 m (2,438 ft). Acid mine drainage from the Lima Mine pollutes the portion of the study basin drained by Snowy Creek, above Laurel Run. The Banner Mine pool is controlled by the main borehole discharge located near the Maryland - West Virginia border at an elevation of 729 m (2,393 ft). Discharges associated with the Banner Mine complex pollute the portion of the study basin drained by Laurel Run.

3. Additional inundation and stabilization of the Lima and Banner mine pools is necessary to reduce acid mine drainage pollution. Abatement at the Lima Mine is possible by constructing a subsurface dam (continuous clay core dam). At the Banner Mine, a mine pool level control lake will inundate additional deep mine workings and stabilize the mine pool. Implementation of these two projects will eliminate 90 percent of acid mine drainage discharges in the Snowy Creek - Laurel Run basin.

4. Areas affected by past surface mining will remain above the proposed mine pool level control lake of the Banner Mine at an elevation of 750 m (2,460 ft) and will require regrading and revegetation to improve the aesthetic appearance of the basin.

5. Previous studies by the Maryland Water Resources Administration (WRA) indicate that the Youghiogheny River is severely degraded by acid mine drainage from the Snowy Creek - Laurel Run Basin. Data collected during this study shows that Snowy Creek contributes a mean acid load of 4,663 kg/day (10,282 lb/day) to the Youghiogheny River.

6. The proposed abatement project will eliminate at least 3,437 kg/day (7,383 lb/day) of the acid load resulting from abandoned mine drainage in the Snowy Creek - Laurel Run Basin. This reduction will reduce mean acid loadings on the Youghiogheny River by an equal amount. The affected section of the Youghiogheny River from its confluence with Snowy Creek

to its confluence with the Little Youghiogheny River, some 7 km (4.4 miles) can now be improved.

7. Abatement of abandoned mine drainage will result in a cleaner water resource and a better environment for the Snowy Creek - Laurel Run Basin and the Youghiogheny River. By cleaning up 6.3 km (3.9 miles) of stream in Maryland, 1.5 km (0.9 miles) of stream in West Virginia, and creating a new lake having 17.4 km (10.8 miles) of shoreline, improvements to fish and wildlife habitats will be expected.

8. The development of a wildlife refuge and/or recreational facilities may result as secondary impacts of the proposed project.

9. Definite social and economic gains will result from the cleaner environment made possible through the demonstration project. Protection of the Youghiogheny River and its environment will be achievable.

SECTION 3

RECOMMENDATIONS

1. Approval and funding should be granted to proceed with the detailed design engineering, construction, and monitoring phases of the demonstration project.

2. Reclamation of the Snowy Creek - Laurel Run Basin should be accomplished according to the following priorities:

a. Reclamation of the Snowy Creek portion of the basin should be accomplished by constructing a continuous clay core dam in the vicinity of the Lime Mine to eliminate acid mine drainage responsible for the pollution of the creek above Laurel Run.

b. Reclamation of the Laurel Run portion of the basin should be accomplished by constructing an earth dam that will create a mine pool level control lake to raise the Banner Mine pool which is responsible for 90 percent of the acid mine drainage in Laurel Run.

c. Abandoned surface mines in the Arnold Run and Freeport areas, should be regraded and revegetated above the impoundment shoreline.

3. A monitoring program should be constructed for sampling immediately above and below areas under abatement and at the mouth of Snowy Creek to assess the effectiveness of the project.

4. A new movable wall bulkhead mine seal design should be employed for seals of underground entries in the Ashby-Pendergast mine.

5. Interstate agreements on funding, acquisition, responsibilities and control should be set forth between the State of West Virginia and the State of Maryland as soon as possible to implement the demonstration project.

6. Involvement of Federal and State conservation agencies (such as U.S. Fish and Wildlife) and/or regional planning agencies will prove beneficial toward the possible development of secondary benefits derived from the abatement project.

SECTION 4

JURISDICTIONAL FRAMEWORK

This section establishes the legal authority for the State or for other agencies. A review of agencies involved with acquisition, design, construction and protection, and the relevant regulations under which they operate will be included to determine how effectively the demonstration project could be implemented under such agencies and standards.

COGNIZANT AUTHORITY

The following report has been conducted under the direction of the U.S. Environmental Protection Agency (EPA). The Water Pollution Control Act of 1972, PL 92-500, grants EPA its authority in water pollution matters. Section 107 of the Water Pollution Control Act, "Mine Water Pollution Control Demonstrations," addresses itself to selecting project watersheds to be used as examples of techniques developed to control mine drainage pollution. In the selection of project watersheds, EPA is directed to give "preference to areas with the greatest present or potential value for public use for recreation, fish and wildlife, water supply and other public uses."

The Snowy Creek - Laurel Run Demonstration Project is funded through a grant to the West Virginia Department of Natural Resources. The Department of Natural Resources is responsible for the supervision and administration of the demonstration project. Legislative authority to conduct such projects is granted to the Department of Natural Resources in the form of the Surface Mining and Reclamation Act and the Water Pollution Control Act of the Code of West Virginia. Administration of these laws under the Department of Natural Resources is performed by the Division of Reclamation and the Division of Water Resources.

The Division of Reclamation was established by the Surface Mining and Reclamation Act and is responsible for administering and enforcing all laws related to surface mining. The Division has control over land, water, soil restoration, and reclamation of all surface-mined lands. Section 20-6-3 of the Surface Mining and Reclamation Act grants the Division of Reclamation this authority.[1]

The Division of Water Resources is charged with the Administration and enforcement of the Water Pollution Control Act, Article 5A, Chapter 20 of the Code of West Virginia, and it receives its authority from this Act. Sections 20-5A-2, 20-5A-3, 20-5A-3a and 20-5A-4 of the Water Pollution

Control Act set the parameters that guide the Division of Water Resources. The Division of Water Resources has been designated as the water pollution control agency for the State of West Virginia.

In summary, the Department of Natural Resources will be totally responsible for the implementation of the demonstration project, either through the Division of Water Resources or the Division of Reclamation or both.

EXISTING AND PROPOSED STANDARDS

Snowy Creek and Laurel Run are considered public streams, and they are therefore subject to the water quality standards regulated by the Division of Water Resources. The Administrative Regulations of the State of West Virginia, Series I, Sections 3 and 5 outline the general water quality standards applicable to the State waters. Section 3, "General Conditions Not Allowable in State Waters," establishes the general parameters on water quality standards for the State. Section 5, "Acid Mine Drainage Control Measures," sets forth specific conditions applicable to acid mine drainage discharges.

Snowy Creek, a headwater tributary of the Youghiogheny River, is also subject to more stringent water use and water quality criteria as established by Sections 6 and 13 of the West Virginia Administrative Regulations, Series II. Section 6, "General and Water Use Categories," defines the types of water uses in the State. Section 13, "Water Uses and Water Quality Criteria," develops the water quality standards that apply to all tributaries of the Youghiogheny River that are interstate with Maryland and Pennsylvania. Table 1 is a summary of water quality standards pertaining to acid mine drainage discharge as found in Section 13.

SITE ACQUISITION

Abatement plans for the Lima Mine and Banner Mine areas will require that limited amounts of property be procured and that releases be obtained to perform certain segments of construction on lands not purchased.

Land acquisition is not a major concern in the project. Both the State of West Virginia and the State of Maryland have the legal capabilities to acquire land for such a project. A joint venture between Federal and State governments is considered necessary in order to fund the cost of the project.

Abatement at the Lima Mine will require that a release or permission to execute construction be obtained from the individual property owners. Certain segments of the Lima Mine abatement design may be executed by the active surface operator. Releases on approximately 4.9 ha (12 acres) will be required at the Lima Mine site. Acquisition of these releases should be obtained by the West Virginia Department of Natural Resources.

TABLE 1. WATER QUALITY CRITERIA PERTAINING TO ACID MINE DRAINAGE

Constituent	Concentrations
Dissolved Oxygen	Not less than 5 mg/l at any time.
pH	Values normal for the waters in the area in question; however, generally held between 6.0 and 8.5, except streams carrying significant quantities of acid mine drainage shall have a pH of not less than 5.5.
Threshold Odor	Not to exceed a threshold odor number of 8 at 40°C, as a daily average.
Toxic Substance	Not to exceed 1/10 of the 96-hour median tolerance limit.
Nitrates	Not to exceed 45 mg/l.
Chlorides	Not to exceed 100 mg/l.
Phenol	Not to exceed .001 mg/l.
Cyanide	Not to exceed .025 mg/l.
Fluoride	Not to exceed 1.0 mg/l.
Selenium	Not to exceed .01 mg/l.
Arsenic	Not to exceed .01 mg/l.
Barium	Not to exceed .50 mg/l.
Cadmium	Not to exceed .01 mg/l.
Chromium (Hexavalent)	Not to exceed .05 mg/l.
Lead	Not to exceed .05 mg/l.
Silver	Not to exceed .05 mg/l.

Note: In special cases where the facts warrant, more stringent standards, or exceptions to the above standards, may be established in the individual case with the approval of the Environmental Protection Agency.

Source: Section 13 of the West Virginia Administrative Regulations, Series II, "Water Uses and Water Quality Criteria."

The Banner Mine abatement design will require approximately 270.3 ha (668 acres) to relocate an existing right-of-way and provide an impoundment area elevating the proposed mine pool. Areas located below an elevation of 749.8 m (2,460 ft) immediately behind the breast of the proposed earth dam, will be inundated. A deep mine seal will be required at the Ashby-Pendergast Mine; therefore a release to enter and construct such a seal will be necessary. Regrading and revegetation at the Arnold Run and Freeport areas will also require a release to enter and perform necessary work.

The Banner Mine abatement design project is situated on the Maryland-West Virginia border. The breast of the proposed dam is located in Maryland, and the impoundment is located largely in West Virginia. The Ashby-Pendergast Mine is located near Crellin, Maryland. Therefore, while the impact of the abatement design and its physical construction are of interstate importance, acquisition of land and releases to perform work would require interstate cooperation between the State of Maryland and the State of West Virginia.

AUTHORITY FOR FUNDING

The abatement project for the Snowy Creek basin is considered an interstate project. The State of West Virginia, with the assistance of the U.S. EPA, has funded the feasibility study. Construction of the proposed abatement designs will greatly reduce acid mine drainage entering Snowy Creek and the Youghiogheny River, both of which are interstate streams. With the reduction of acid mine drainage originating in West Virginia, both the State of Maryland and of West Virginia derive benefits from the project.

Approximately 7.8 km (4.81 miles) of stream will be made cleaner with the implementation of the proposed abatement project. On Snowy Creek, 6.2 km (3.85 miles) of stream will be made cleaner of which 76 percent, or 4.7 km (2.92 miles) is found in Maryland. Laurel Run, below the breast of the proposed dam, will add another 1.6 km (0.98 miles) entirely in Maryland. In addition to these cleaner stream reaches shared by both Maryland and West Virginia, the proposed impoundment having 17.7 km (11.08 miles) of shoreline will also be a direct benefit to each state.

Finally with the reduction of acid mine drainage in Snowy Creek - Laurel Run, the Youghiogheny River can not return to its natural state, a goal Maryland is presently striving toward.

In view of the nature of the proposed program it is recommended that the State of West Virginia and the State of Maryland in cooperation with Federal agencies develop a joint method of funding the demonstration project.

WATER AND MINERAL RIGHTS

A mineral evaluation of the Snowy Creek Basin as well as the remainder of West Virginia is presently being conducted. Results of the evaluation will not be made public at this time. However, it has been determined that proposed abatement designs are in areas that have been economically mined out. Therefore, purchase of mineral rights has not been included.

The streams of Snowy Creek and Laurel Run are considered to be public streams, therefore private ownership is not an issue.

PREVENTION OF FUTURE POLLUTION

It has been determined that sufficient water quality standards exist and that proper authority has been granted the Division of Water Resources to administer and enforce said standards. Since the Division of Water Resources is the State's regulatory agency and has the authority to enforce water quality standards, implementation of the demonstration project in accordance to these regulations is anticipated.

Active mining in the project basin could be continued without any adverse effects to the proposed abatement project. Present standards and reclamation laws are sufficiently stringent to protect the proposed project.

The most recent mining permit issued to the mining operation within the basin included special conditions which were in harmony with the "clay core dam" abatement plan outlined in this project.

This addition of the continuous "clay core dam" concept, added by the operators in response to the project, and approved by the West Virginia Department of Natural Resources, exemplifies the concern and willingness to protect the project basin by all parties.

SECTION 5

INVENTORY AND FORECAST

The section presents an inventory of physical, economic, and social conditions found in the Snowy Creek - Laurel Run Basin. An outline of physical conditions, including information obtained during subsurface explorations is presented. A complete water resource evaluation that emphasizes the results of the water quality network, which was monitored for 1 year, is summarized. Socio-economic conditions in the study basin and the effects of outlying areas on the basin are observed.

PHYSICAL CONDITIONS

The project is situated in Preston County, West Virginia and Garrett County, Maryland, as shown on Figure 2. Areas affected by acid mine drainage are situated in the lower portion of the basin and pollute clean water derived from the upper segments of the basin before being discharged into the Youghiogheny River. The basin is drained by two major streams, Snowy Creek and Laurel Run. Laurel Run enters Snowy Creek just before the Snowy Creek confluence with the Youghiogheny River.

Physiography

The Snowy Creek - Laurel Run study area in West Virginia is situated in the headwaters of the Youghiogheny River Basin within the Allegheny Mountain section of the Appalachian Plateaus physiographic province. The plateau in this area has been strongly dissected by erosion and the topography reflects the lay and alternation of hard and soft bedrock. Typical steep-sided, v-shaped valleys separated by rounded hilltops are noticeable only where the drainage cuts though resistant sandstone bedrock layers. Broader and more gentle rolling hills and valleys are commonly found elsewhere in the immediate survey area.

Overall topographic relief is about 250 m (820 ft), with extremes ranging from a low elevation of 727 m (2,385 ft) above sea level at the confluence of Snowy Creek and the Youghiogheny River near Crellin, Maryland, to a high elevation of 992 m (3,256 ft) on Brushy Knobs at the edge of the watershed to the southwest. In the immediate area of concern, 60 m (200 ft) to 120 m (400 ft) of relief is more common. The configuration of the watershed drainare system reflects both the northeast plunge of bedrock structure as well as basinward dips of resistant bedrock units.

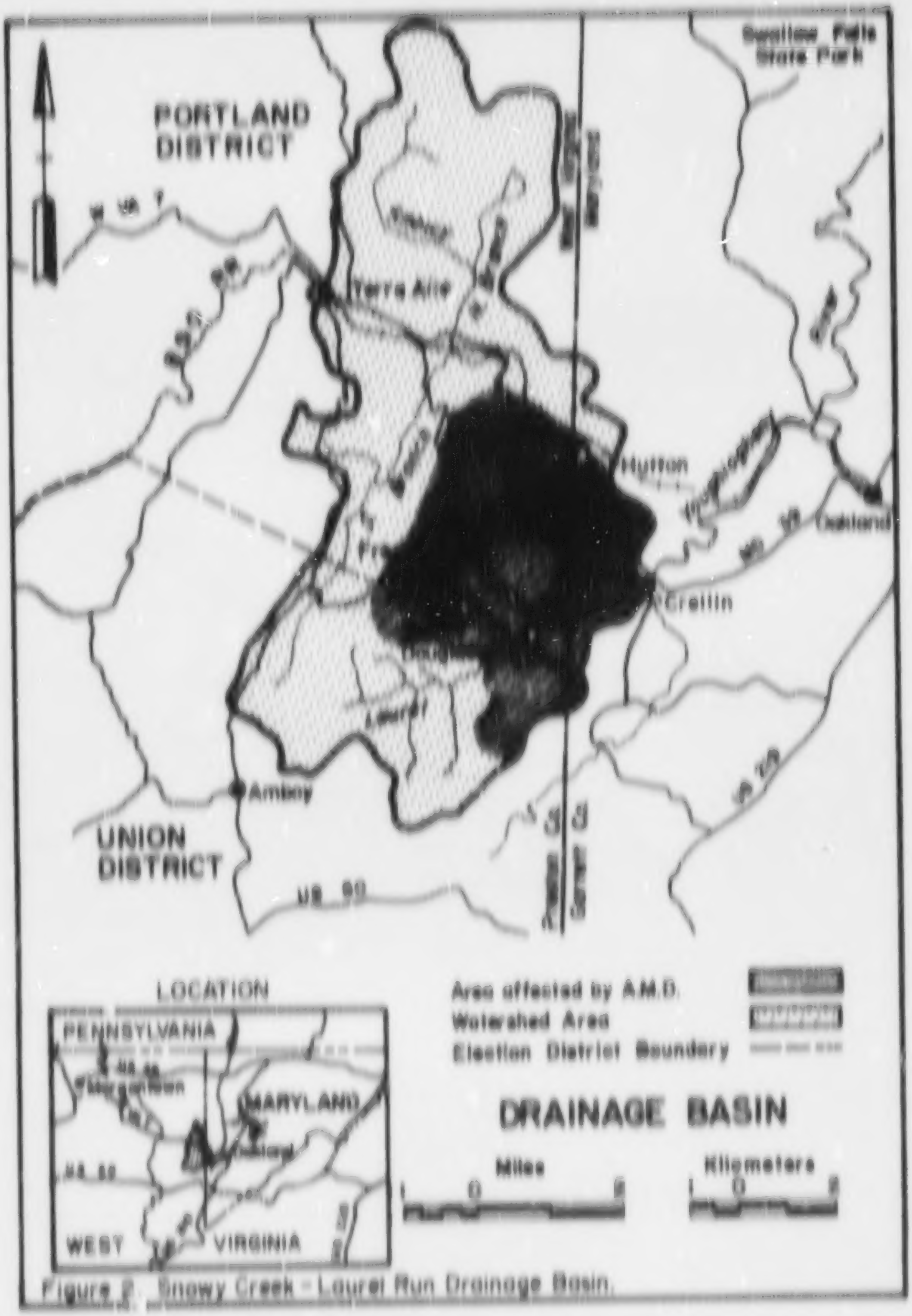

Swallow Falls State Park
PORTLAND DISTRICT
Terra Alta
Hutton
Oakland
Crellin
Amboy
UNION DISTRICT
US 50
US 219
LOCATION
PENNSYLVANIA
MARYLAND
WEST VIRGINIA
Area affected by A.M.D.
Watershed Area
Election District Boundary
DRAINAGE BASIN
Miles
Kilometers

Figure 2. Snowy Creek - Laurel Run Drainage Basin.

Geology

The study area occupies the center and margins of the southwest-northeast trending Mount Carmel syncline. The syncline is bounded by the Briery Mountain anticline to the west and the Deer Park anticline to the east. There is a northeastward plunge to the syncline, as shown by structure contours plotted on the accompanying geologic map (Figure 3). The relatively broad and flat axis of the syncline here is bounded by a pronounced steepening of bed attitude toward the paralleling anticlines. About 260 m (853 ft) of coal-bearing strata are preserved in the syncline referable to the Pottsville, Allegheny, and Conemaugh groups of the Pennsylvania System (Figure 4).

The basal Pottsville Group is made up mainly of massive sandstone and siltstone, with only minor thin coal horizons. Coals in the Pottsville Group are unimportant; they tend to be less than 0.5 m (1.6 ft) and generally are not minable. Exposures were found at the Mercer and Quakertown horizons. No pollution problems were found.

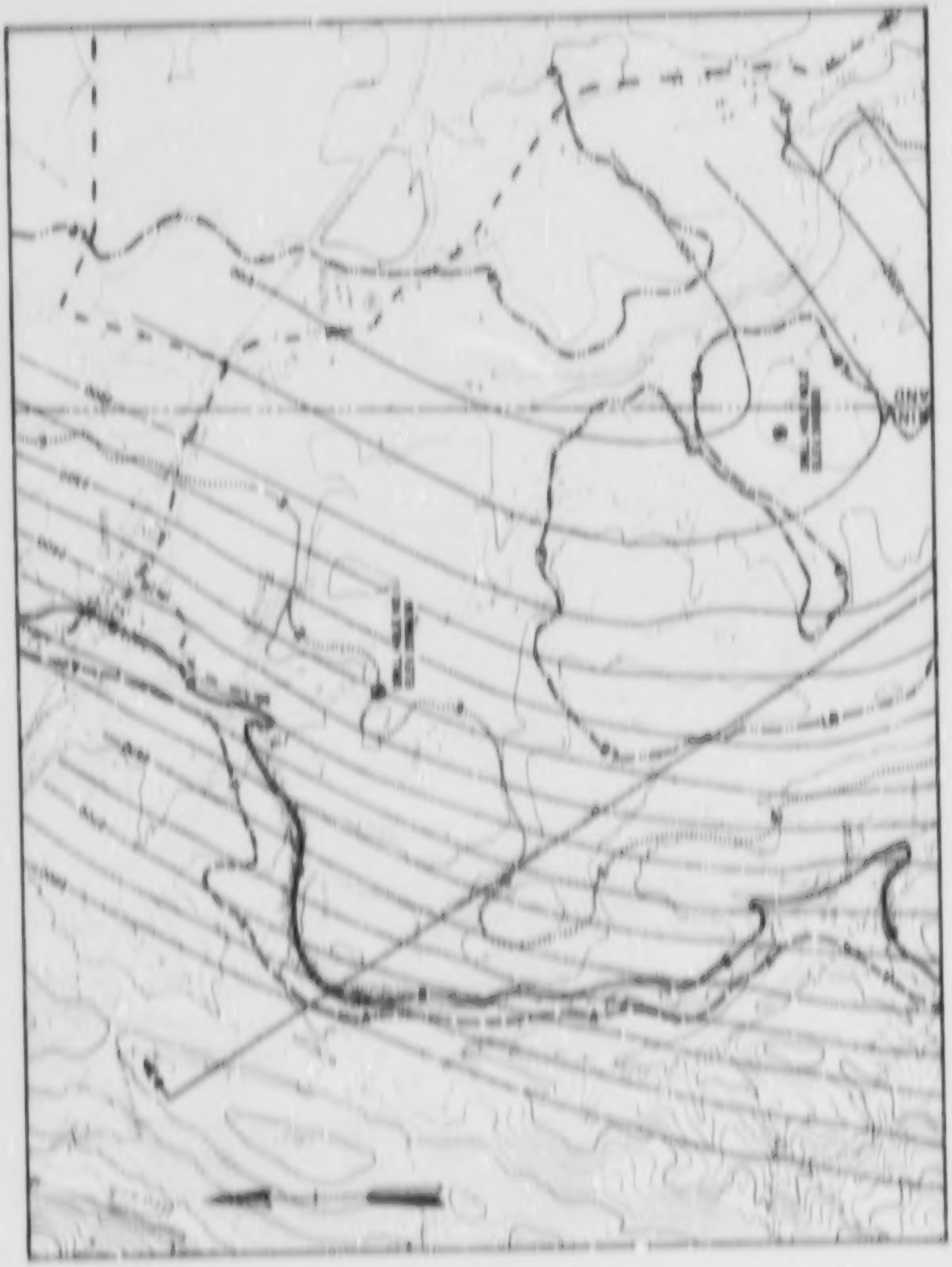
The Allegheny Group includes those strata found between the Lower Clarion and the Upper Freeport coal horizons. The group includes cyclic sequences of shale, sandstone, coal and clay. Light to dark shale, ranging from sandy shale to clay shale, is more abundant than other lithologies. Sandstone is common to the lower half of the Allegheny Group where it laterally interfingers with, or massively replaces, a shaly sequence. The persistent minable lower Kittanning coal horizon has been used as the key horizon, providing both stratigraphic and structural control in the study area.

The Lower Clarion coal near the base of the group was reported as 0.3 to 1.2 m (1 to 4 ft) thick and of poor quality but has been prospected only at a few places. No significant mining of this bed was found anywhere in the study area. This coal is found 24 and 30 m (79 ft and 98 ft) below the Lower Kittanning coal datum.

The Lower Kittanning coal is the principal mined coal of the area. This coal is very persistent and generally consists of a split bed containing a middle 1.0- to 1.5- m (3 to 5 ft)- thick black shale parting. The total coal thickness, including partings, is about 3 m (10 ft). Generally, a massive to shaly sandstone 10 m (33 ft) or more thick is found within a few meters of the top of the coal.

Coals noted above the Lower Kittanning in the Allegheny group tend to be thin or lenticular and though prospected and mined very locally, they are of little importance to the project.

The Conemaugh Group in the study area includes all consolidated strata above the position of the Upper Freeport coal horizon. Originally 200 to 230 m (656 to 755 ft) thick, this unit has had all vestiges of its upper two thirds removed by erosion. This group is made up of shale, sandstone, and claystones with a few thin coals. Only the Lower Bakerstown



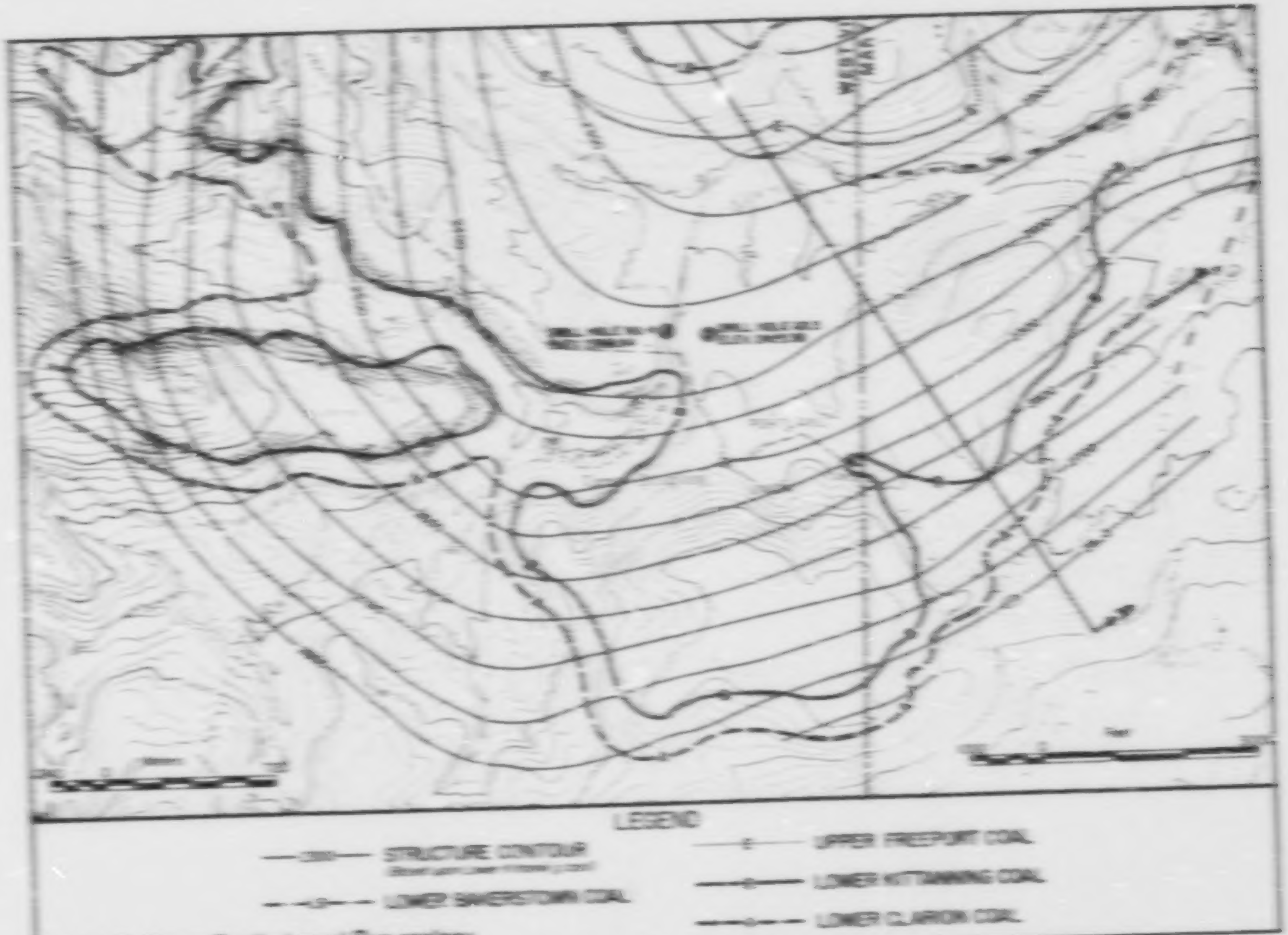

LEGEND
STRUCTURE CONTOUR
LOWER BAKERSTOWN COAL
UPPER FREEPORT COAL
LOWER KITTANNING COAL
LOWER CLARION COAL

Figure 3. Snowy Creek–Laurel Run geology

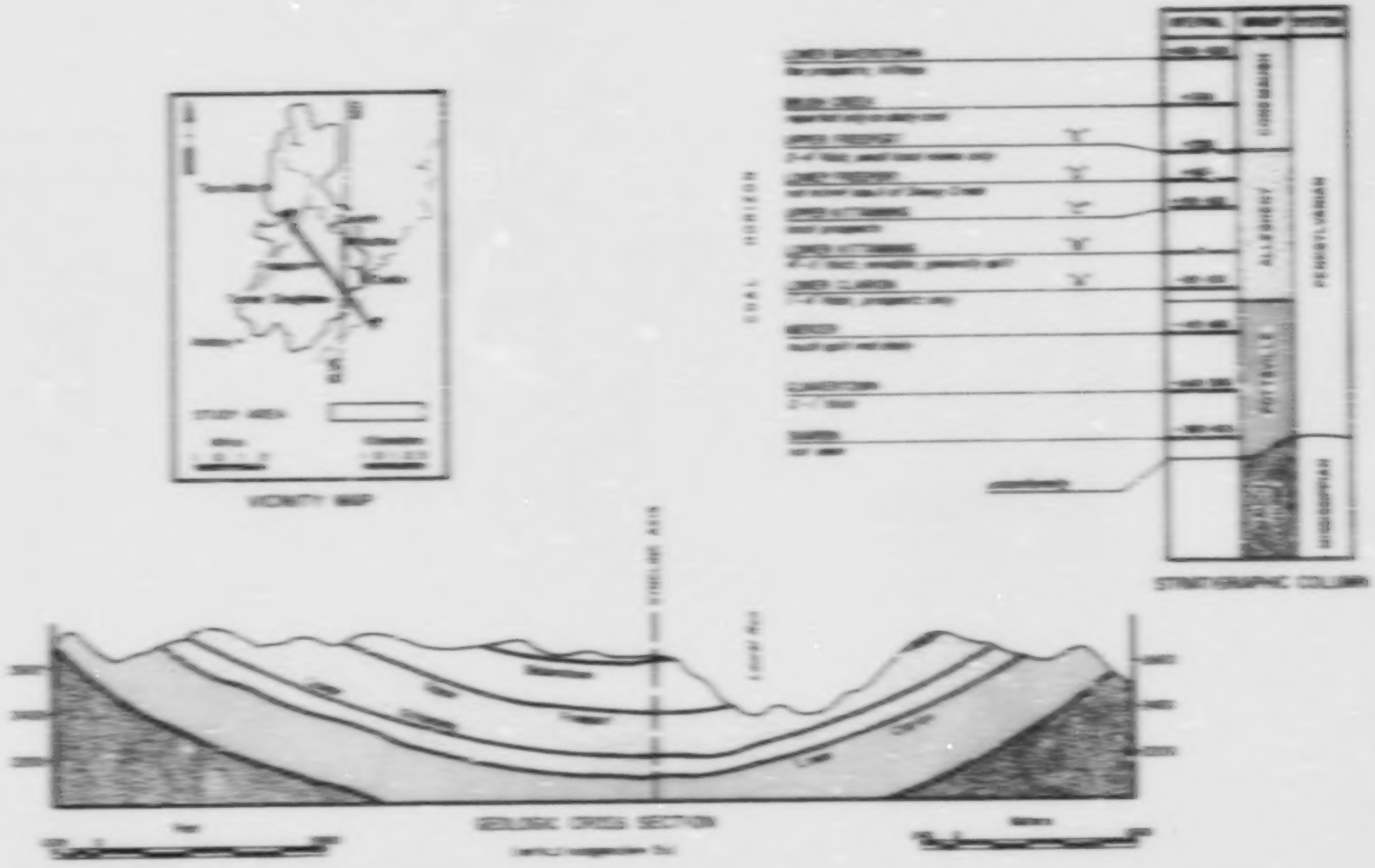

VICINITY MAP
STUDY AREA
COAL HORIZON
CONEMAUGH
ALLEGHENY
POTTSVILLE
PENNSYLVANIAN
MISSISSIPPIAN
STRATIGRAPHIC COLUMN
SYNCLINE AXIS
Laurel Run
GEOLOGIC CROSS SECTION

Figure 4. Geologic data for the Snowy Creek–Laurel Run basin.

coal has been prospected and opened for house coal. The Brush Creek horizon 35 m (115 ft) above the Upper Freeport coal, is usually a carbonaceous.

A thin alluvial fill is present in the Snowy Creek and Laurel Run valleys. The alluvium is seldom as much as 5 m (16 ft) thick in the center of either valley.

Although no true faults were found, a possible fault was reported in the mine workings and may have some displacement. The rocks of the area are fractured both by natural jointing and as a result of subsidence in some areas where the Lower Kittanning coal was extensively mined. Effects of subsidence were particularly noticeable in places where coal was withdrawn less than 30 m (98 ft) below surface. The opened fractures materially affect the hydrology in the vicinity of mining. In such areas, normal perched groundwater supplies are either meager or absent. Depending on the elevation, water either enters the mine or is discharged from the mine when fractures are present in drainage courses.

Subsurface Exploration

Test borings were made during the study to prove geological interpretations, to document the nature of the overburden, and to permit monitoring of the Banner Mine pool level. Locations of these tests and resultant logs are presented as Figures 5 through 9.

Broken strata were found above the B (Lower Kittanning) coal, especially in drill holes 3 and 4, where insufficient pillar support permits varying degrees of subsidence. Test Boring No. 3 is being used to monitor the level of the Banner Mine pool.

An attempt was made to rebore the existing drill hole which is now providing a discharge to Laurel Run near the West Virginia - Maryland State Line. The tools could not be held in alignment because of the presence of a concrete plug and lateral voids in the broken strata. A large amount of concrete had been injected into the hole during 1964 in an unsuccessful attempt to halt this flow. The flow had channeled around the plug material and widened the hole.

Mining

Extensive underground mining has taken place only on the Lower Kittanning coal, and all significant pollution is from this horizon. The extent of this mining and of peripheral strip mining is shown in the accompanying mine development map (Figure 10). The workings shown are principally taken from available mine maps. The direction and extent of some minor workings are assumed in the absence of satisfactory information (Figure 10). The assumed mains are based on position of the entries and reported extent or interpretations of mining methods employed at the time of development.

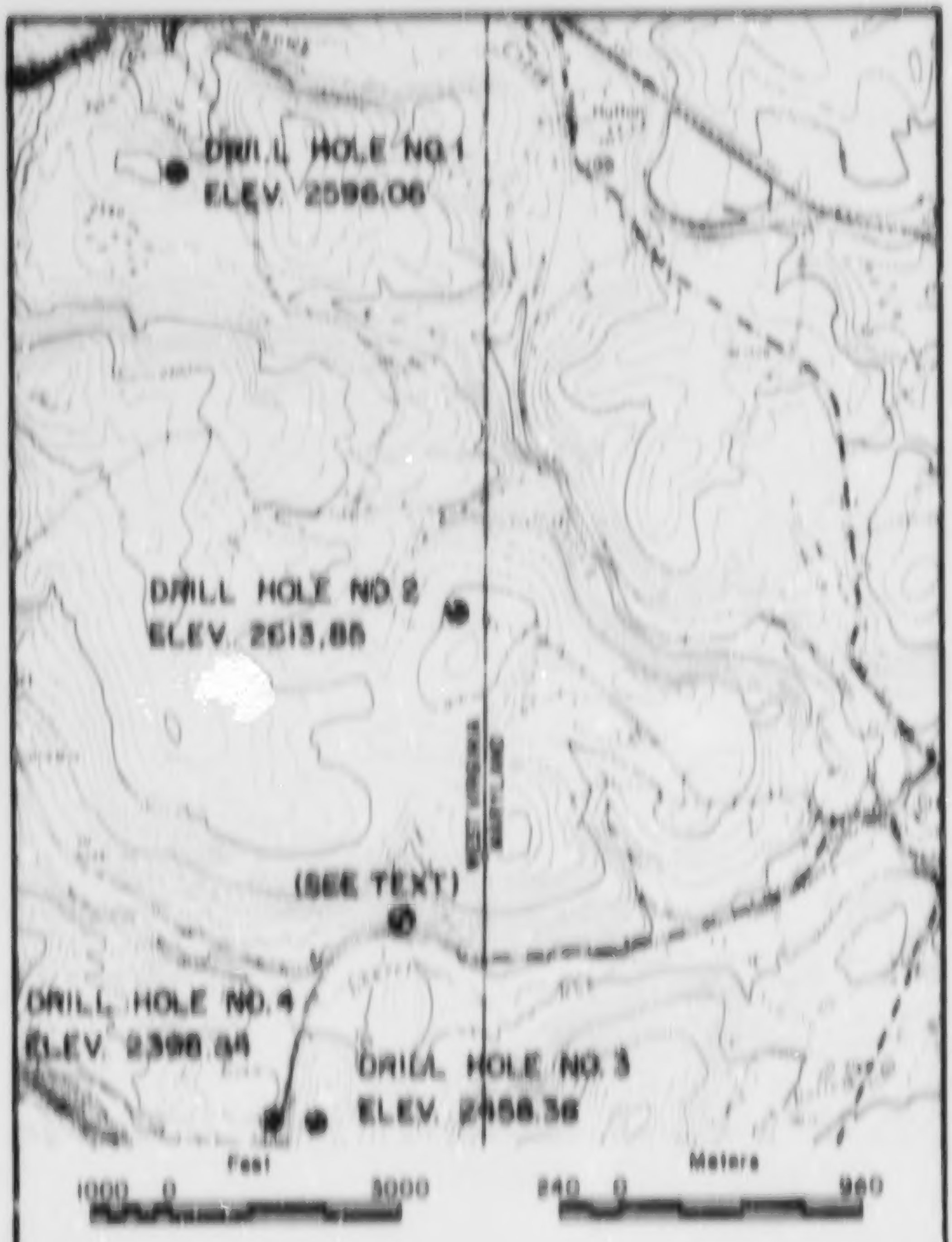

DRILL HOLE NO.1
ELEV. 2596.06
DRILL HOLE NO.2
ELEV. 2613.85
(SEE TEXT)
DRILL HOLE NO.4
ELEV. 2396.84
DRILL HOLE NO.3
ELEV. 2458.38
Feet
1000 0 3000
Meters
240 0 960

Figure 5. Snowy Creek - Laurel Run subsurface exploration

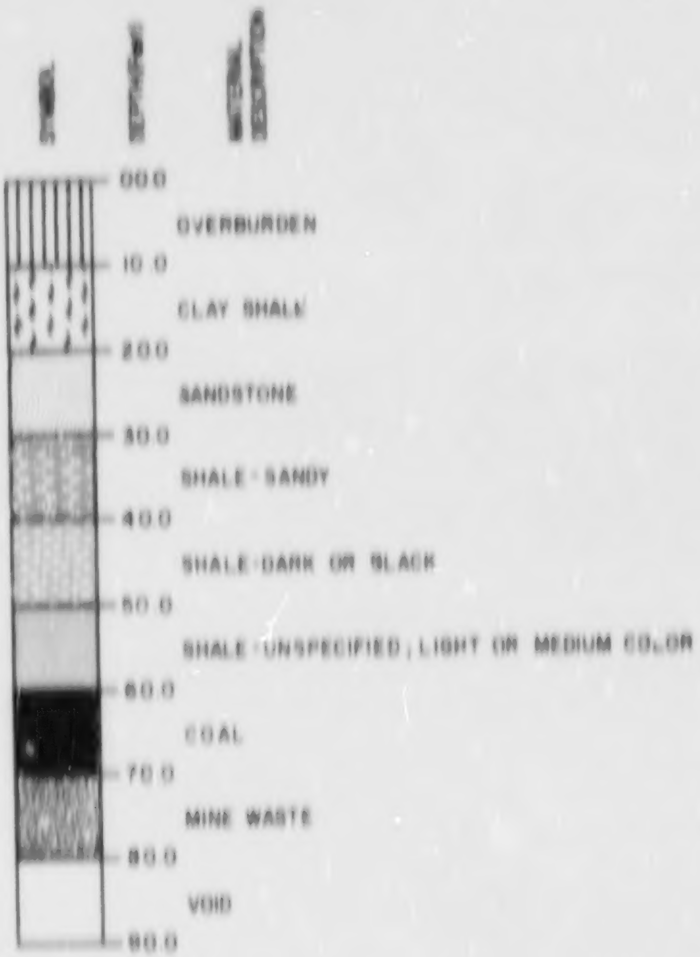

00.0
OVERBURDEN
10.0
CLAY SHALE
20.0
SANDSTONE
30.0
SHALE - SANDY
40.0
SHALE - DARK OR BLACK
50.0
SHALE - UNSPECIFIED; LIGHT OR MEDIUM COLOR
60.0
COAL
70.0
MINE WASTE
80.0
VOID
90.0

Figure 6. Legend for test boring logs.

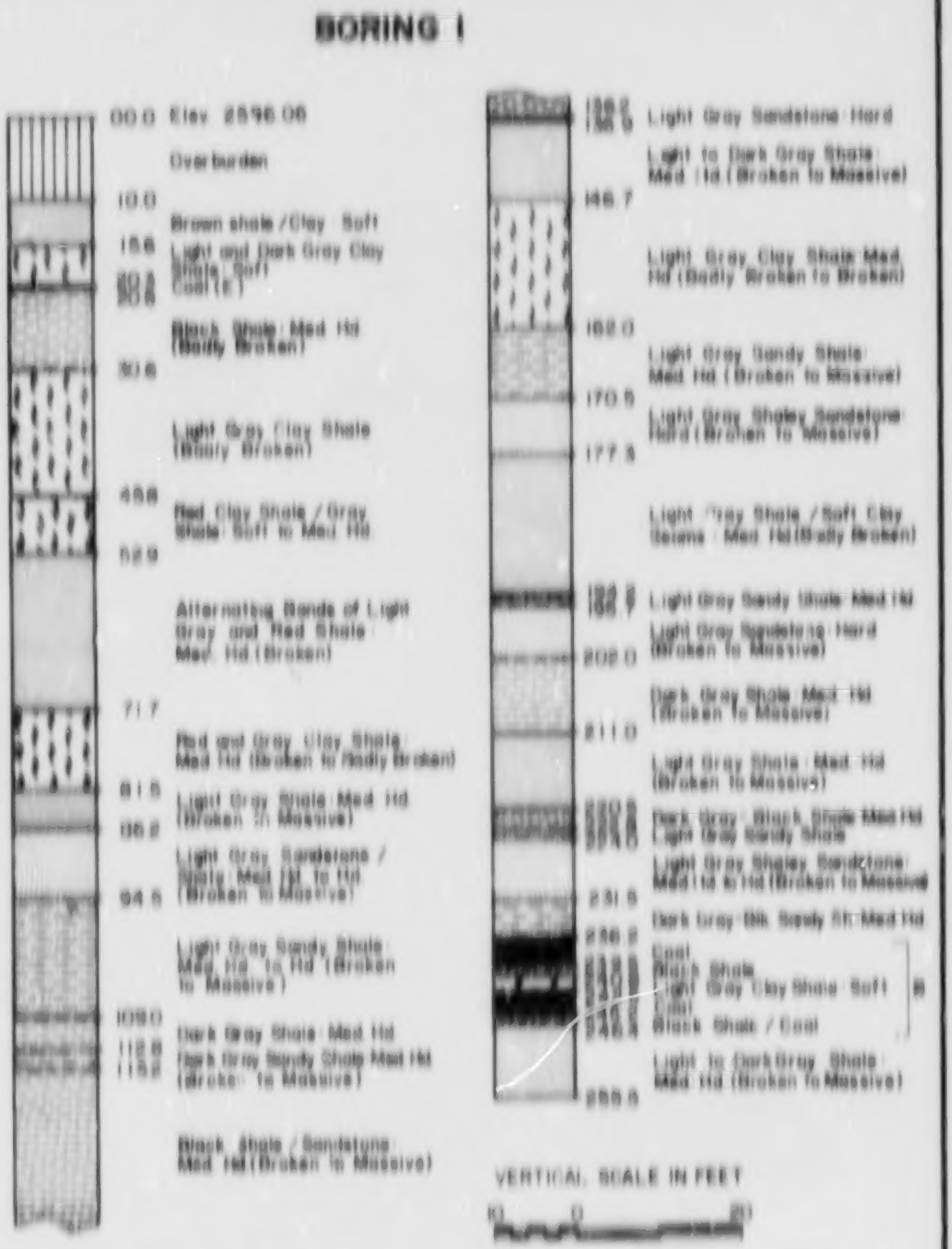

BORING 1
00.0 Elev. 2596.06
Overburden
10.0
Brown shale / Clay : Soft
15.6
Light and Dark Gray Clay Shale : Soft
Coal (?)
Black Shale : Med Hd (Badly Broken)
30.6
Light Gray Clay Shale (Badly Broken)
45.8
Red Clay Shale / Gray Shale : Soft to Med Hd
52.9
Alternating Bands of Light Gray and Red Shale : Med. Hd (Broken)
71.7
Red and Gray Clay Shale : Med Hd (Broken to Badly Broken)
81.5
Light Gray Shale : Med Hd (Broken to Massive)
86.2
Light Gray Sandstone / Shale : Med Hd to Hd (Broken to Massive)
94.5
Light Gray Sandy Shale : Med Hd to Hd (Broken to Massive)
109.0
Dark Gray Shale : Med Hd
112.8
115.2
Dark Gray Sandy Shale : Med Hd (Broken to Massive)
Black Shale / Sandstone : Med Hd (Broken to Massive)
Light Gray Sandstone : Hard
Light to Dark Gray Shale : Med Hd (Broken to Massive)
146.7
Light Gray Clay Shale : Med Hd (Badly Broken to Broken)
162.0
Light Gray Sandy Shale : Med Hd (Broken to Massive)
170.5
Light Gray Shaley Sandstone : Hard (Broken to Massive)
177.5
Light Gray Shale / Soft Clay Seams : Med Hd (Badly Broken)
Light Gray Sandy Shale : Med Hd
Light Gray Sandstone : Hard (Broken to Massive)
202.0
Dark Gray Shale : Med Hd (Broken to Massive)
211.0
Light Gray Shale : Med Hd (Broken to Massive)
Dark Gray - Black Shale : Med Hd
Light Gray Sandy Shale
Light Gray Shaley Sandstone : Med Hd to Hd (Broken to Massive)
231.5
Dark Gray - Blk. Sandy Sh. : Med Hd
236.2
Coal
Black Shale
Light Gray Clay Shale : Soft
Coal
Black Shale / Coal
B
Light to Dark Gray Shale : Med Hd (Broken to Massive)
255.5
VERTICAL SCALE IN FEET
10
0
20

Figure 7. Test boring log number 1.

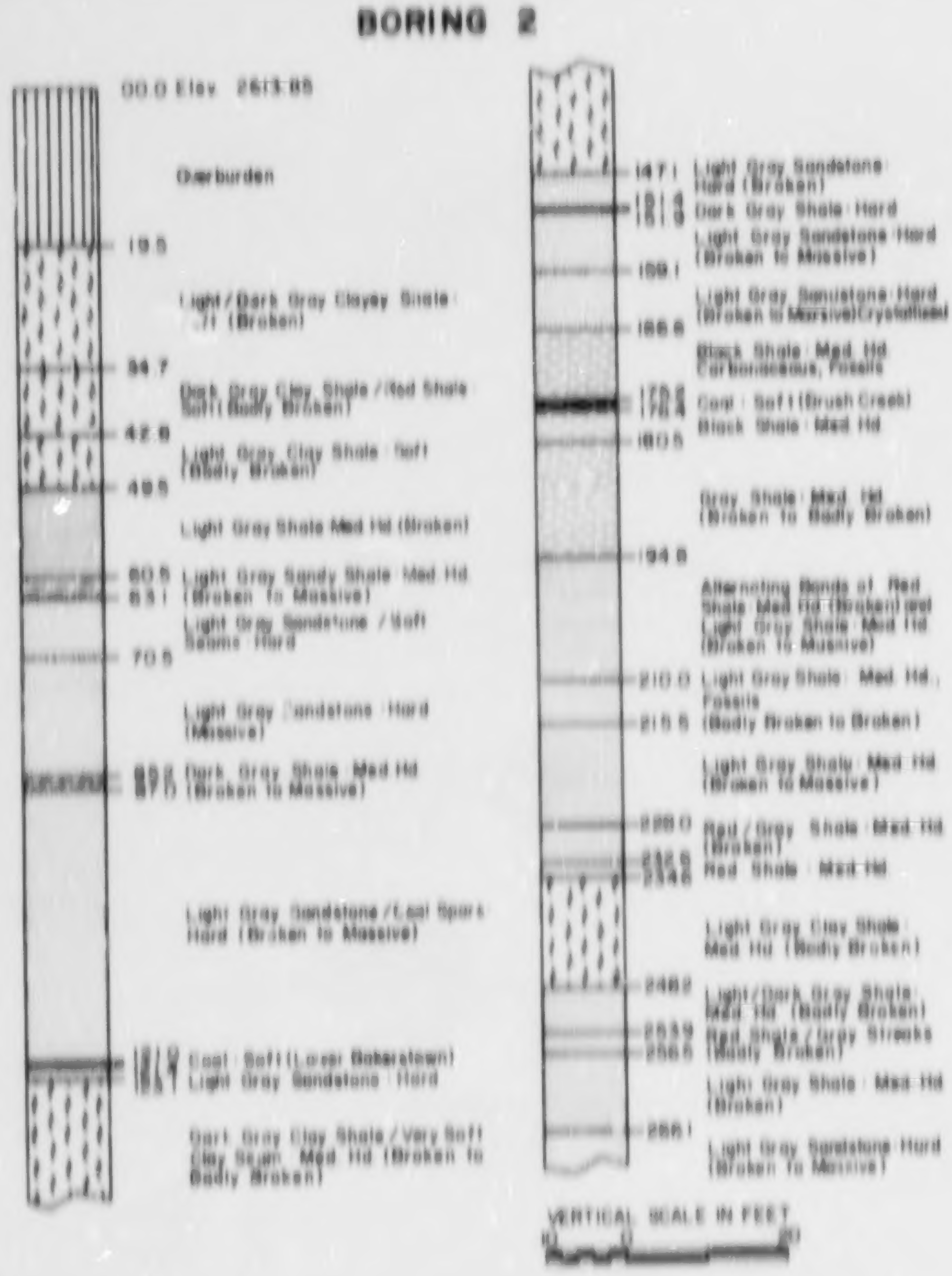

BORING 2
00.0 Elev 2613.85
Overburden
19.5
Light/Dark Gray Clayey Shale: [illegible] (Broken)
34.7
Dark Gray Clay Shale / Red Shale: Soft (Badly Broken)
42.8
Light Gray Clay Shale: Soft (Badly Broken)
49.5
Light Gray Shale Med Hd (Broken)
60.5 Light Gray Sandy Shale: Med Hd
63.1 (Broken To Massive)
Light Gray Sandstone / Soft Seams: Hard
70.5
Light Gray Sandstone: Hard (Massive)
85.2 Dark Gray Shale: Med Hd
87.0 (Broken to Massive)
Light Gray Sandstone / Coal Spars: Hard (Broken to Massive)
121.0 Coal: Soft (Lower Bakerstown)
123.1 Light Gray Sandstone: Hard
Dark Gray Clay Shale / Very Soft Clay Seam: Med Hd (Broken to Badly Broken)
147.1 Light Gray Sandstone: Hard (Broken)
151.3
151.9 Dark Gray Shale: Hard
Light Gray Sandstone: Hard (Broken to Massive)
159.1
Light Gray Sandstone: Hard (Broken to Massive) Crystallized
166.8
Black Shale: Med Hd Carbonaceous, Fossils
175.2
176.4 Coal: Soft (Brush Creek)
Black Shale: Med Hd
180.5
Gray Shale: Med Hd (Broken to Badly Broken)
194.8
Alternating Bands of Red Shale: Med Hd (Broken) and Light Gray Shale: Med Hd (Broken to Massive)
210.0 Light Gray Shale: Med Hd, Fossils
215.5 (Badly Broken to Broken)
Light Gray Shale: Med Hd (Broken to Massive)
228.0 Red / Gray Shale: Med Hd (Broken)
232.5
234.6 Red Shale: Med Hd
Light Gray Clay Shale: Med Hd (Badly Broken)
246.2 Light/Dark Gray Shale: Med Hd (Badly Broken)
253.9 Red Shale / Gray Streaks
256.5 (Badly Broken)
Light Gray Shale: Med Hd (Broken)
266.1
Light Gray Sandstone: Hard (Broken to Massive)
VERTICAL SCALE IN FEET
0
10
20

Figure 8. Test boring log number 2.

BORING 2
(Cont)

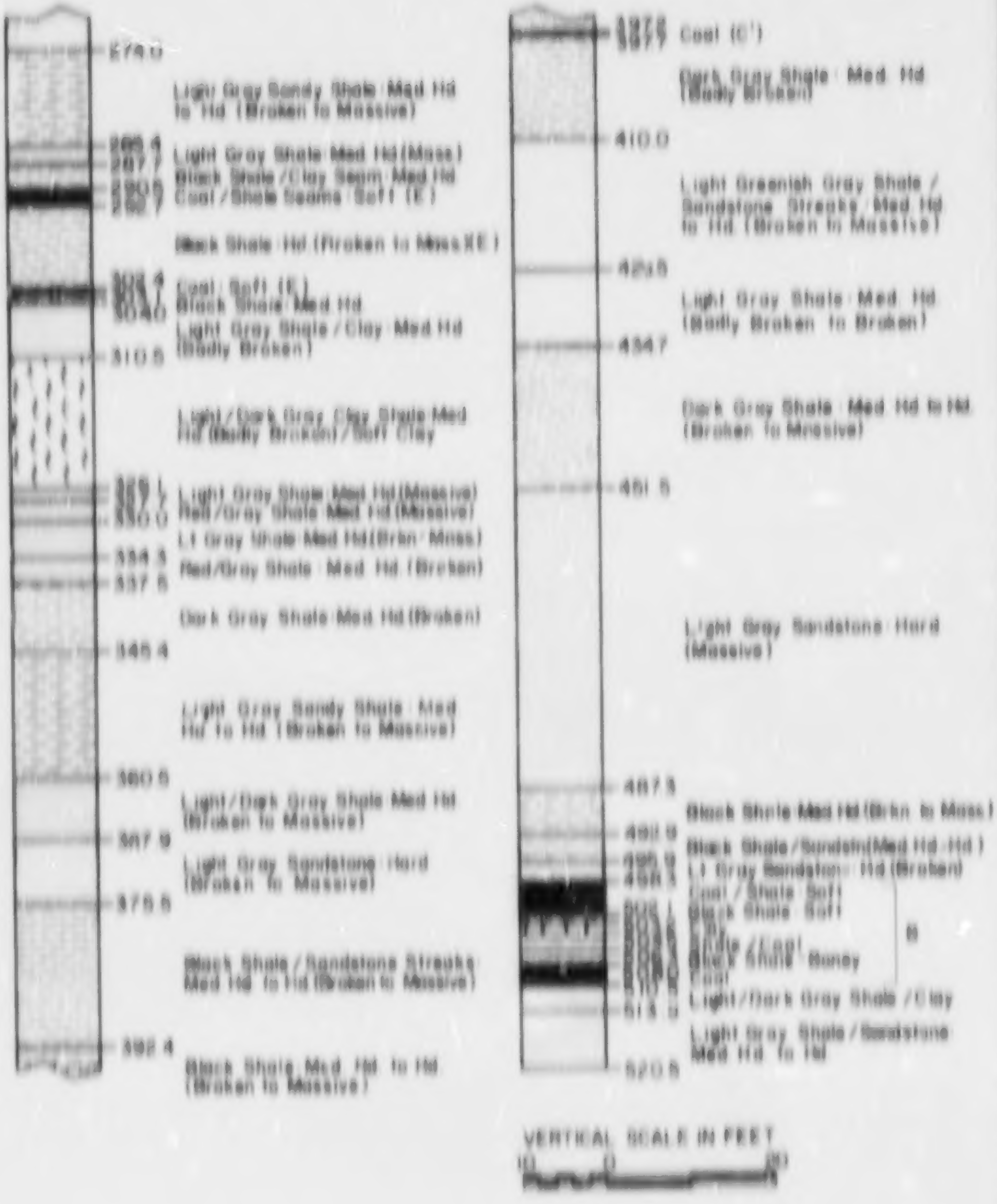

279.0
Light Gray Sandy Shale Med Hd to Hd (Broken to Massive)
285.4
Light Gray Shale Med Hd (Mass)
287.7
Black Shale / Clay Seam Med Hd
290.6
Coal / Shale Seams Soft (E)
292.7
Black Shale Hd (Broken to Mass)(E)
302.4
Coal Soft (E)
303.7
Black Shale Med Hd
304.0
Light Gray Shale / Clay Med Hd (Badly Broken)
310.5
Light / Dark Gray Clay Shale Med Hd (Badly Broken) / Soft Clay
326.1
Light Gray Shale Med Hd (Massive)
327.7
Red / Gray Shale Med Hd (Massive)
330.0
Lt Gray Shale Med Hd (Brkn Mass)
334.3
Red / Gray Shale Med Hd (Broken)
337.5
Dark Gray Shale Med Hd (Broken)
345.4
Light Gray Sandy Shale Med Hd to Hd (Broken to Massive)
360.5
Light / Dark Gray Shale Med Hd (Broken to Massive)
367.9
Light Gray Sandstone Hard (Broken to Massive)
375.5
Black Shale / Sandstone Streaks Med Hd to Hd (Broken to Massive)
392.4
Black Shale Med Hd to Hd (Broken to Massive)
Coal (C')
Dark Gray Shale Med Hd (Badly Broken)
410.0
Light Greenish Gray Shale / Sandstone Streaks Med Hd to Hd (Broken to Massive)
425.5
Light Gray Shale Med Hd (Badly Broken to Broken)
434.7
Dark Gray Shale Med Hd to Hd (Broken to Massive)
451.5
Light Gray Sandstone Hard (Massive)
487.5
Black Shale Med Hd (Brkn to Mass)
492.9
Black Shale / Sandstn (Med Hd Hd)
Lt Gray Sandston Hd (Broken)
Coal / Shale Soft
Black Shale Soft
Clay
Shale / Coal
Black Shale Boney
Coal
B
Light / Dark Gray Shale / Clay
513.3
Light Gray Shale / Sandstone Med Hd to Hd
520.5
VERTICAL SCALE IN FEET
0
10
20

Figure 8 continued

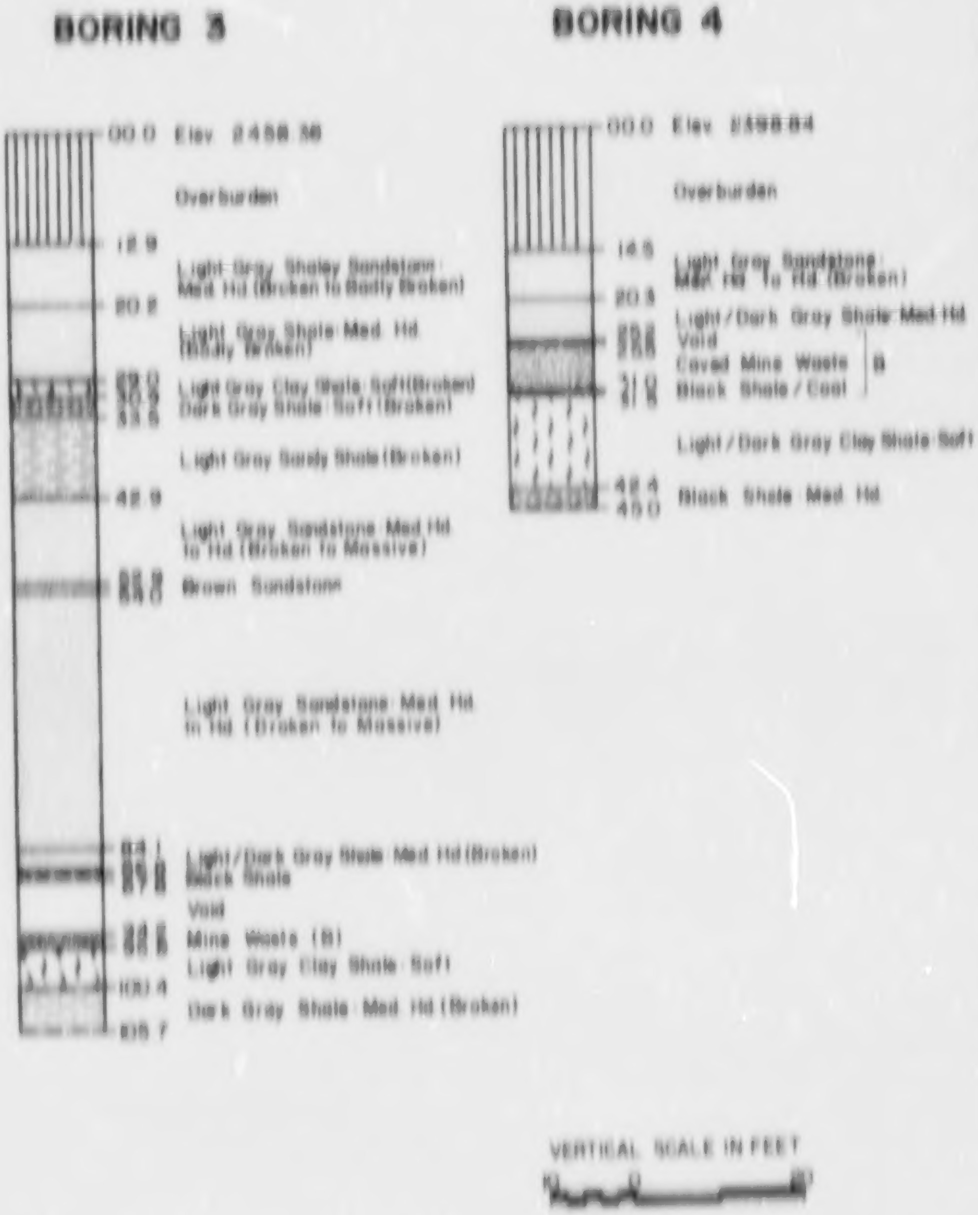
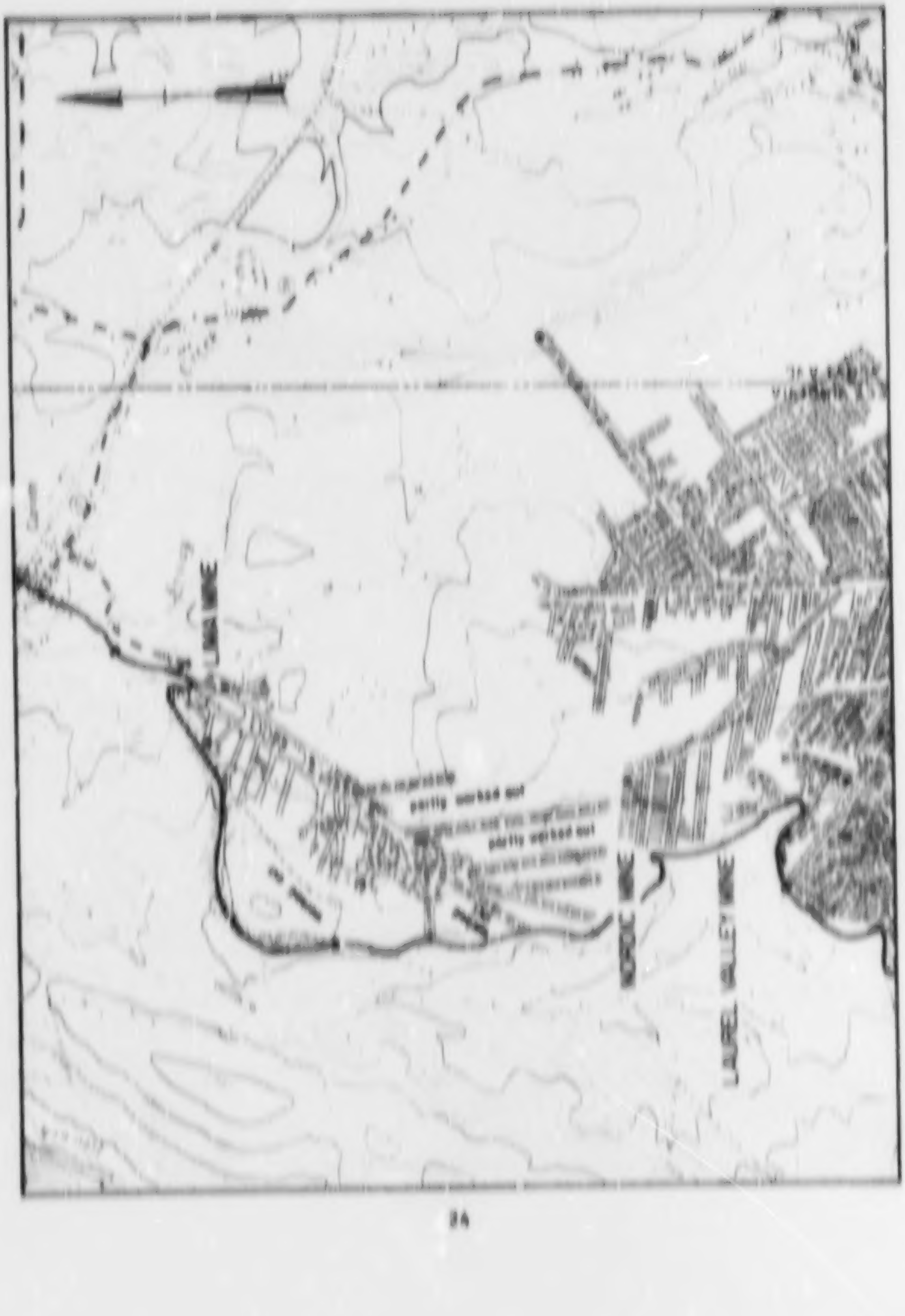

BORING 3
00.0
Elev. 2458.36
Overburden
12.9
Light Gray Shaley Sandstone: Med Hd (Broken to Badly Broken)
20.2
Light Gray Shale: Med. Hd (Badly Broken)
Light Gray Clay Shale: Soft (Broken)
Dark Gray Shale: Soft (Broken)
33.5
Light Gray Sandy Shale (Broken)
42.9
Light Gray Sandstone Med Hd to Hd (Broken to Massive)
Brown Sandstone
Light Gray Sandstone Med Hd to Hd (Broken to Massive)
84.1
Light/Dark Gray Shale Med Hd (Broken)
Black Shale
Void
Mine Waste (B)
Light Gray Clay Shale: Soft
100.4
Dark Gray Shale: Med Hd (Broken)
105.7
BORING 4
00.0
Elev. 2398.84
Overburden
14.5
Light Gray Sandstone: Med Hd To Hd (Broken)
20.5
Light/Dark Gray Shale: Med Hd
Void
Caved Mine Waste
B
Black Shale / Coal
Light/Dark Gray Clay Shale: Soft
42.4
Black Shale: Med Hd
45.0
VERTICAL SCALE IN FEET
10
0
20

Figure 9. Test boring logs number 3 and number 4


LIMA MINE
partly worked out
partly worked out
NORDIC MINE
LAUREL VALLEY MINE

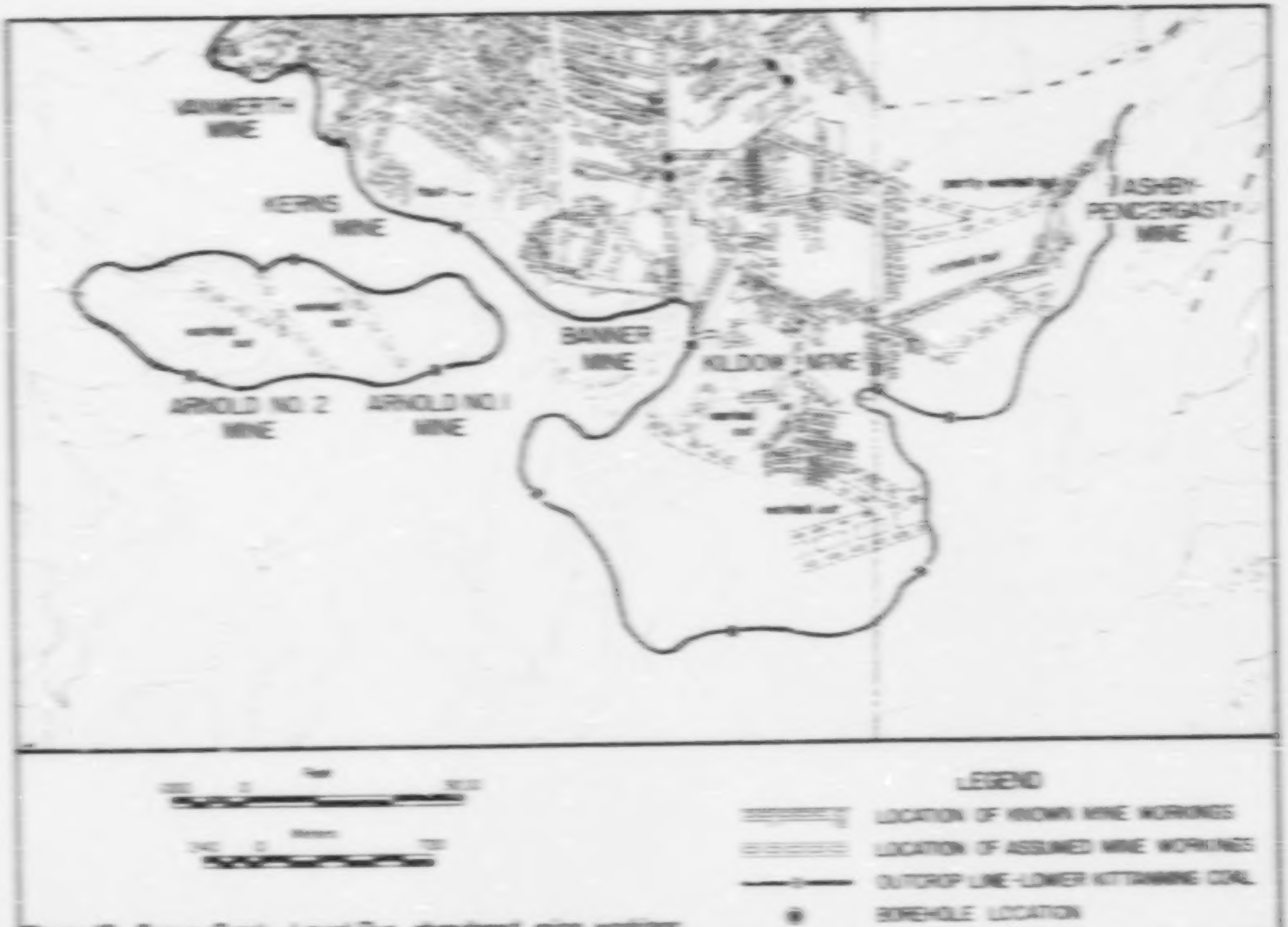

VANWERTH MINE
KERNS MINE
ARNOLD NO. 2 MINE
ARNOLD NO. 1 MINE
BANNER MINE
KILDOW MINE
ASHBY-PENDERGAST MINE
LEGEND
LOCATION OF KNOWN MINE WORKINGS
LOCATION OF ASSUMED MINE WORKINGS
OUTCROP LINE-LOWER KITTANNING COAL
BOREHOLE LOCATION

Figure 10. Snowy Creek - Laurel Run abandoned mine workings.

The presence of a mine pool in the Lima Mine about 14 m (46 ft) above the elevation of the Banner Mine pool strongly suggests that no connection exists between these pools at the present time.

Mining was started in the Snowy Creek - Laurel Run Basin at Corinth in 1897. The first mine, the Corinth Mine, was opened by the Oakland Coal and Coke Company in what they believed to be the Upper Freeport Coal seam (now identified as the Lower Kittanning Coal Seam).

The mine portal was located approximately 700 m (2,297 ft) southwest of the center of Corinth. The main heading was driven to the southwest to allow for natural drainage from the mine. Most of the mine development was to the west of the main heading, and mining was to the rise. Several butt headings were driven almost due south and extended far enough to come very close to if not actually intercepting, the workings in the Banner Mine.

The Oakland Coal and Coke Company mined coal in the Corinth Mine until 1910, when the records show that mining was continued under the name of the Jordan Coal Company, which mined coal until 1912. From 1912 until 1922, the records show no production recorded from the Corinth Mine. In 1922, the Lindsey Coal Mining Company opened operations and named the mine the Lima No. 1. Production records continue from the Lindsey Coal Mining Company until 1932. Here again, no production records are available until 1942, when the Princess Pat Coal Company began reporting production and continued until 1947. This we believe was the last of the production from the deep mine.

In 1953, the L & L Coal Company and the Mersing Coal Company began a surface mining operation along the outcrop of the Lower Kittanning Coal Seam. Surface mining was carried on until 1960. In 1975, the Grafton Coal Company began surface strip mining operations very near the portal of the Lima No. 1 mine and continued the surface mine operation along the existing highwalls. All of these operations cut into the old mine workings of the Lima Mine. Figure 11 locates the present active surface mine operations of the Grafton Coal Company.

The majority of underground mining was done to the rise in this mine employing the room and pillar system. This was accomplished by driving the main heading into the body of coal on the rise of the seam (up dip). Branch entries (butt headings) were then driven off the main heading at approximately 107 m (350 ft) intervals. The butt headings were driven slighly up dip in order to provide natural drainage and to aid in hauling. The rooms were also driven from the butt headings on the rise (up dip) and were spaced at approximately 15 m (50 ft) intervals.

The area mined down dip is much smaller because of the inability to properly handle the water created by mining down structure. We feel that water rather than the quality of the coal was the controlling factor in the extent of mining to the east of the main headings.

By 1897, there were two commerical mines in production in the Turner Douglass area: the Arnold No. 1 and the Guthrie Mine (production figures

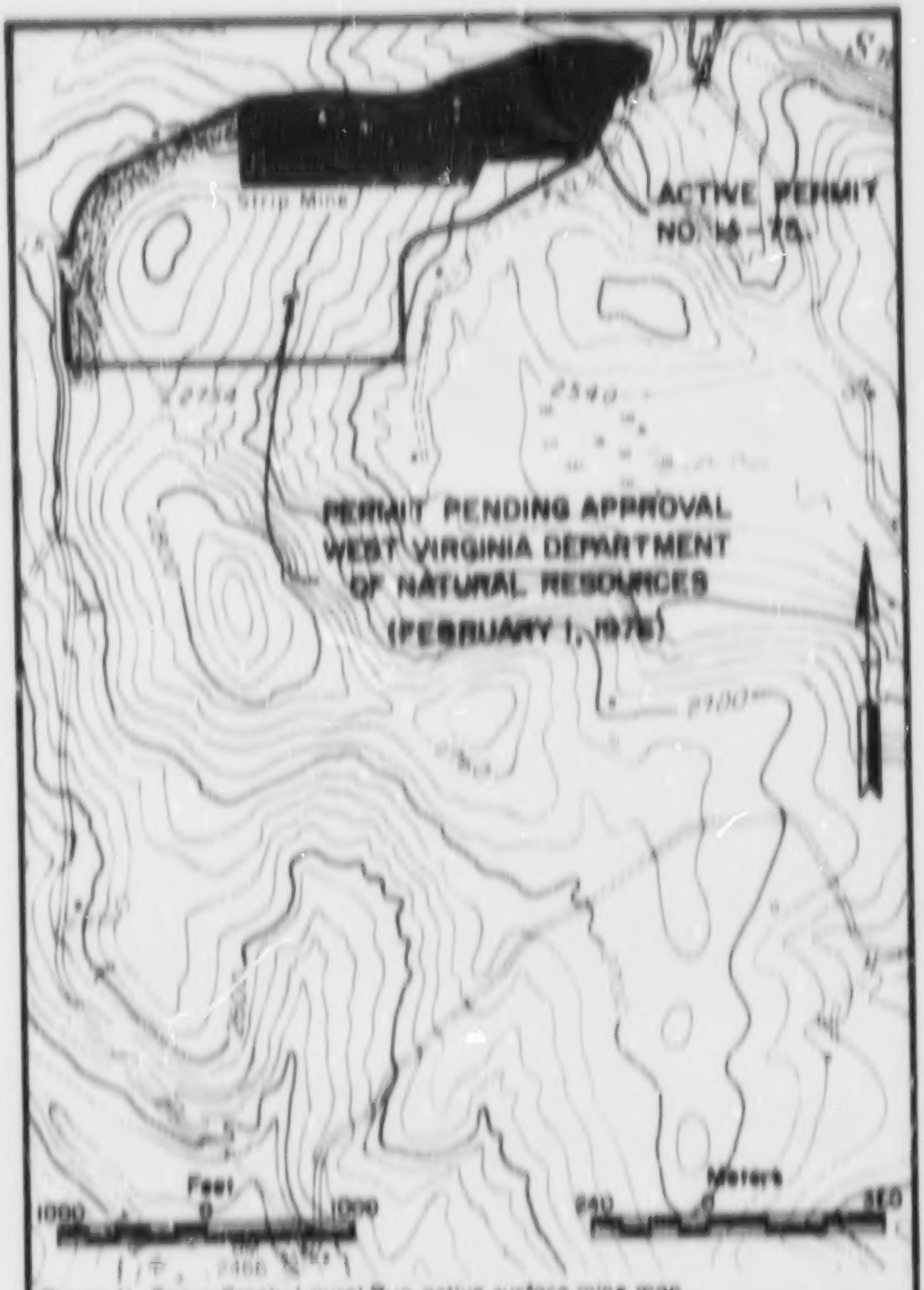

Strip Mine
ACTIVE PERMIT
NO. 14-75.
2754
2540
PERMIT PENDING APPROVAL
WEST VIRGINIA DEPARTMENT
OF NATURAL RESOURCES
(FEBRUARY 1, 1978)
2700
Feet
1000
0
1000
Meters
240
0
300

Figure 11. Snowy Creek-Laurel Run active surface mine map.

were not available until 1913). The original producer of coal was the Preston Lumber and Coal Company. In 1905, the Kendall Lumber Company purchased the Preston Lumber and Coal Company, and by 1919, coal producing was its main enterprise. At this time there were four active mines in the area--they were the Arnold No. 1 and No. 2, Guthrie, and Turner Douglass (later named the Banner Mine).

The main portal of the Banner mine is located at the east end of Turner Douglass and the main heading was driven almost due north and is over 3.2 km (2 miles) long. Butt headings were driven off the main heading to the left and right and rooms were then driven off the butt headings.

All of the work was done by hand in the Turner Douglass area until 1925, when the Kendall Lumber Company sold its holdings (which included the Turner Douglass Mine) to the newly formed Stanley Coal Company. The Stanley Coal Company, which named the Turner Douglass Mine the Banner No. 1, began a modernization program, and by 1927 it was 95 percent mechanized.[3]

As shown on Figure 10, the deep mine workings were extended almost to the "grass roots" on the western side of the main headings. It is also shown that the Nordic, Laurel Valley, Vanworth, Kerns, Banner, Kildow, and Ashby-Pendergast Mines are all interconnected. We believe that the intent was at one time to cut through and connect the Lima Mine with the Banner Mine. Based on the mine development maps and productions reported by the Grafton Coal Company, these mines show about 75 percent recovery. The limiting factor in mining on the eastern side of the main heading was the amount of water that could be handled economically.

The Arnold No. 1 and No. 2 mines were not connected to the Banner Mine. (No mine maps were available for the area.) Mine production records indicate the area was partially mined out.

An area of Lower Kittanning Coal partially deep-mined is located in the study area south of Turner Douglass. The area has one small mine driven only a short distance and then abandoned. According to information furnished by local residents the thickness and quality of the coal changed in the area and was not mineable. This has not been verified by drilling and there does seem to be a potential mining area at this location.

Surface mining was extensively carried out in the Turner Douglass-Freeport area. Most outcrop coal was removed in surface mine operations. During surface mining many old workings were cut into, thus demonstrating the fact that deep mine headings were driven to the "grass roots."

Many of the mines were known by different names. Available mine production records for the Snowy Creek Basin are presented in Appendix A.

Soils

Soils in the study area are typically residual soils derived from interbedded acidic sandstone, siltstone, and shale. The Gilpin series dominates the uplands grading downslope to the related, poorly drained

Ernest and Atkins soils in the valley floor. The principal soils found are listed in Table 2.

The Gilpin soils are moderatly deep, well-drained silt loams with variable amounts of slabby or stony material present. This series locally includes patches of more sandy Dekalb soil on steeper slopes and patches of claypan Wharton soil in flat upland areas.

All of the soils are acidic, ranging from pH 4.2 to pH 5.0, and tend to be best suited for wildlife habitat, woodland, or pasture lands. Disturbed areas can be returned to usefulness with minimal fertilizing and liming.[4]

TABLE 2. SOILS CLASSIFICATION

Symbol	Name
As	Atkins silt loam
Bm	Brinkerton silt loam, 3-10 percent slopes
Bn	Brinkerton stony silt loam, 0-15 percent slopes
Ca	Calvin silt loam, 3-10 percent slopes
Cb	Calvin silt loam, 10-20 percent slopes
Cd	Calvin silt loam, 20-30 percent slopes
Ce	Calvin silt loam, 20-30 percent slopes
Cf	Calvin silt loam, 30-40 percent slopes
Cg	Calvin silt loam, 30-40 percent slopes
Cm	Cavode silt loam, 3-10 percent slopes
Co	Cavode silt loam, 10-20 percent slopes
Cp	Clarksburg silt loam, reddish variant, 3-10 percent slopes
Db	Dekalb channery sandy loam, 10-20 percent slopes
Dc	Dekalb channery sandy loam, 20-30 percent slopes
Dg	Dekalb loam, 10-20 percent slopes
Dk	Dekalb loam, 20-30 percent slopes
Dr	Dekalb stony loam, 20-30 percent slopes
Du	Dekalb stony sandy loam, 3-20 percent slopes
Dv	Dekalb stony sandy loam, 20-30 percent slopes
Dw	Dekalb stony sandy loam, 30-40 percent slopes
Eb	Ernest silt loam, 3-10 percent slopes
Ef	Ernest stony silt loam, 3-20 percent slopes
Gk	Gilpin silt loam, 3-10 percent slopes
Gn	gilpin silt loam, 10-20 percent slopes
Go	Gilpin silt loam, 10-20 percent slopes
Gp	Gilpin silt loam, 20-30 percent slopes
Gr	Gilpin silt loam, 20-30 percent slopes
Gv	Gilpin stony silt loam, 3-10 percent slopes
Gw	Gilpin stony silt loam, 10-20 percent slopes
Gx	Gilpin stony silt loam, 20-30 percent slopes
Gy	Gilpin stony silt loam, 30-40 percent slopes

(continued)

TABLE 2 (continued)

Symbol	Name
Lb	Lickdale stony silt clay loam, 0-15 percent slopes
Mb	Mine dumps
Mc	Melvin silt loam
Ra	Rayne silt loam, 3-10 percent slopes
Ss	Strip mine spoil
Wa	Wharton silt loam, 3-10 percent slopes
Wc	Wharton silt loam, 10-20 percent slopes
Wd	Wharton silt loam, 10-20 percent slopes, severely eroded
We	Wharton silt loam, 20-30 percent slopes
Wf	Wharton silt loam, 20-30 percent slopes, severely eroded

Source: United States Department of Agriculture, Soil Conversation
Survey - Preston County, West Virginia

WATER RESOURCES

Climatology

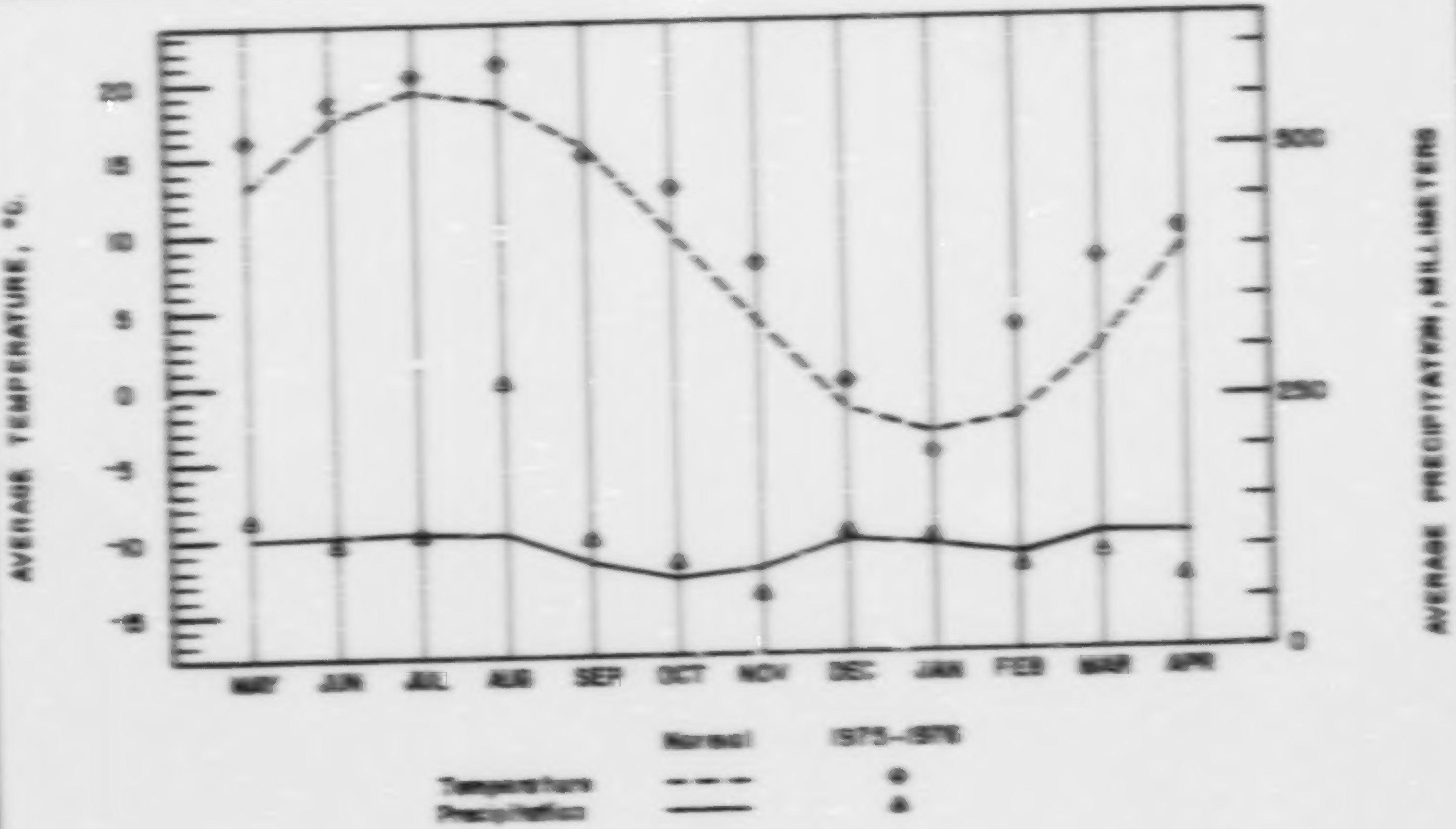
The National Oceanic and Atmospheric Administration maintains a weather station at Terra Alta, West Virginia, in the northwest corner of the study basin. The exact location of the weather station has been moved once since 1952. Data collection, however, has remained in the same general location. Therefore the early gage known as Hopemont (from 1952 to 1964) and the present Terra Alta No. 1 gage were combined to obtain a longer historical data base. These climatological patterns are summarized by the normal values found on Table 3 and Figure 12. The normal values were then used as a base for comparison against the recorded values also expressed on Table 3 and Figure 12.

Temperature--

Generally the temperatures recorded during the sampling period were above normal. Average temperatures for February and March 1976 ranged far above normal. During this period, an extremely early spring thaw occurred, with temperatures reaching as high as 19° C (67° F) on February 29.

These warmer temperatures caused the existing accumulation of snow and ice to be melted, thus creating a high runoff on February 15. But because of the shortened period in which water would have been stored in the form of ice and snow, the runoff potential during this early spring thaw was held to a minimum.

In summary, the recorded temperatures were generally 2.3° C above normal. The early spring thaw was directly responsible for lower than anticipated flows recorded during the spring runoff.



Source : National Oceanic and Atmospheric Administration, 1951-1974 Climatological Data

Figure 12. Climatological data for the Terra Alta, W.Va. weather station.

TABLE 3. CLIMATOLOGICAL DATA
TERRA ALTA, WEST VIRGINIA WEATHER STATION

Month	Temperature (° C) R	Temperature (° C) N	Rainfall (mm) R	Rainfall (mm) N	Rainfall (mm) *
May 1975	16.3	13.2	136	120	60
June 1975	18.7	17.5	110	121	48
July 1975	20.2	19.3	121	122	36
August 1975	20.9	18.5	273	122	8
September 1975	14.9	15.5	116	94	28
October 1975	12.7	9.7	89	76	23
November 1975	7.8	3.9	55	85	85
December 1975	0.0	-2.0	120	109	42
January 1976	-3.9	-3.6	118	102	31
February 1976	3.1	-2.7	88	94	50
March 1976	6.8	1.9	97	117	62
April 1976	9.4	8.4	74	115	77
Average Total	10.6	8.3	1,397	1,272	

R = Value recorded during sampling program
N = Normal value
* = Percent of time rainfall can be expected to be exceeded.
Source: National Oceanic and Atmospheric Administration Climatological Data Summary.

Precipitation--

Precipitation values recorded were also generally above normal. The wettest month of this sampling period was August 1975, during which time 272.5 mm (10.73 in) of rainfall was recorded. This recorded amount was the second wettest August on record for the gage and was also the wettest location in the State during August 1975. Total precipitation recorded at the Terra Alta gage for the water year ending December 1975 was 1,599 mm (62.95 in).

Tabulation of total precipitation during the sampling period indicates that 1,397 mm (55 in) was recorded from May 1975 to April 1976. Precipitation data collected during the periods of August 11 to September 2, 1975, and December 26, 1975, to January 1, 1976, deserve special emphasis.

Beginning on August 11 and ending on August 17, 127.3 mm (5.01 in) of rainfall was recorded with 43.2 mm (1.7 in) recorded on August 14. This initial storm quickly saturated the dry soil and recharged the groundwater table. Four days later high stream flows were recorded, but they were less than anticipated because of the increased groundwater storage.

A second period of rainfall began on August 23 and ended on September 2. During this period, 132.3 mm (5.21 in) was recorded, with 45.7 mm (1.8 in) of it recorded on August 26. By this time, the groundwater table had been recharged and soil conditions were in a semisaturated state. Relatively high flows were therefore recorded on September 2.

The second period of marked precipitation occurred during the winter holiday season beginning December 26, 1975, and ending January 1, 1976. During this period, 90.4 mm (3.56 in) of rainfall was recorded, with 37.6 mm (1.48 in) of it occurring on January 1. This heavy rain, coupled with temperatures reaching 8° C (47° F) caused rapid melting of existing snows on the ground. Thus the highest flows for the entire study period were recorded on January 1.

In summary, historical data show (Figure 13) that the 1,397 mm (55 in) of precipitation recieved during the sampling period can be expected to be exceeded only 32 percent of the time.

Sampling Program

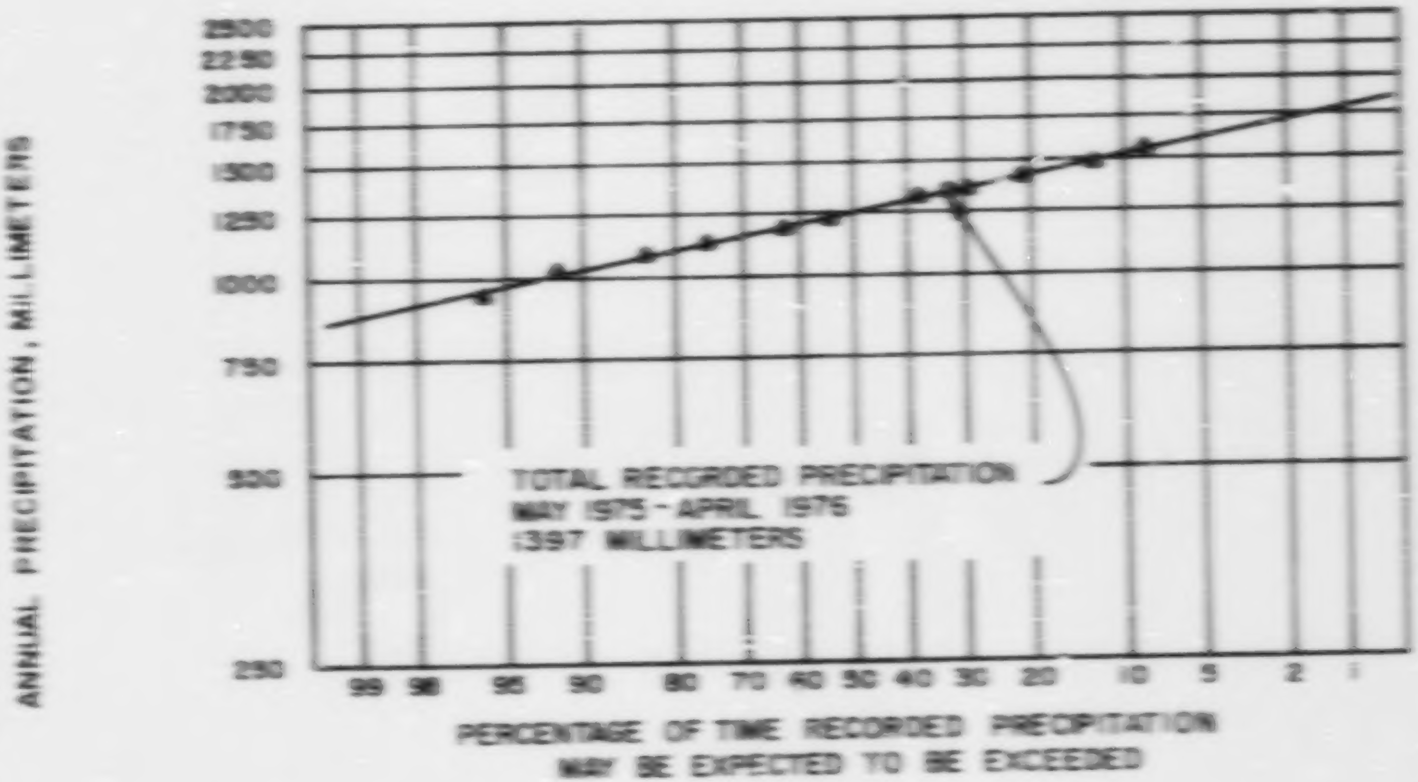
A detailed stream sampling network was constructed and maintained for 1 hydrologic year. Figure 14 identifies sample stations employed during the study. Appendix B defines each sampling station using the Universal Transverse Mercator system.

Beginning in May 1975 and ending in May 1976, over 900 sample locations were checked and over 850 chemical analyses were performed. Generally, routine chemical analysis for the basic mine drainage parameters of pH, acidity, alkalinity, sulfates, total iron, ferrous iron, specific conductance, aluminum, and manganese were conducted.

On each major pollution source, additional comprehensive water quality analyses were also conducted. These samples include the routine analyses mentioned above plus analyses for cadmium, calcium, chromium (hexavalent), chromium (total), copper, cyanide, lead, magnesium, mercury, potassium, zinc, arsenic, turbidity, total solids, suspended solids, total organic carbon, chloride, fluoride, chemical oxygen demand and hardness. Methods use in testing for these chemical parameters are a part of Appendix C.

Water samples from stations were grouped into four categories; weekly, bi-weekly, monthly, or supplementary (grab) samples. Samples collected weekly monitored discharges having major impact on Snowy Creek. Stations sampled bi-weekly were either of secondary importance as pollution sources or were stations established to survey the entire drainage basin. Monthly water quality samples were collected in the headwaters of Snowy Creek and Laurel Run. Additional supplementary samples were taken at random throughout the basin. Data obtained during the study are recorded in Appendix C and will be reviewed later in the report.

Flow measurements were recorded at all pollution sources and major stream sampling stations. Measurements were obtained at stream sampling stations using a Gurley pygmy-type current meter to measure the velocity through a known cross section of the stream. Bridges and culverts were used where possible to establish a constant cross section. After periods of high water, cross sections were revised as required. Bench marks were



Source: National Oceanic and Atmospheric Administration, 1951-1974 Precipitation Data.

Figure 13. Annual precipitation probability for the Terra Alta, W.Va. weather station.

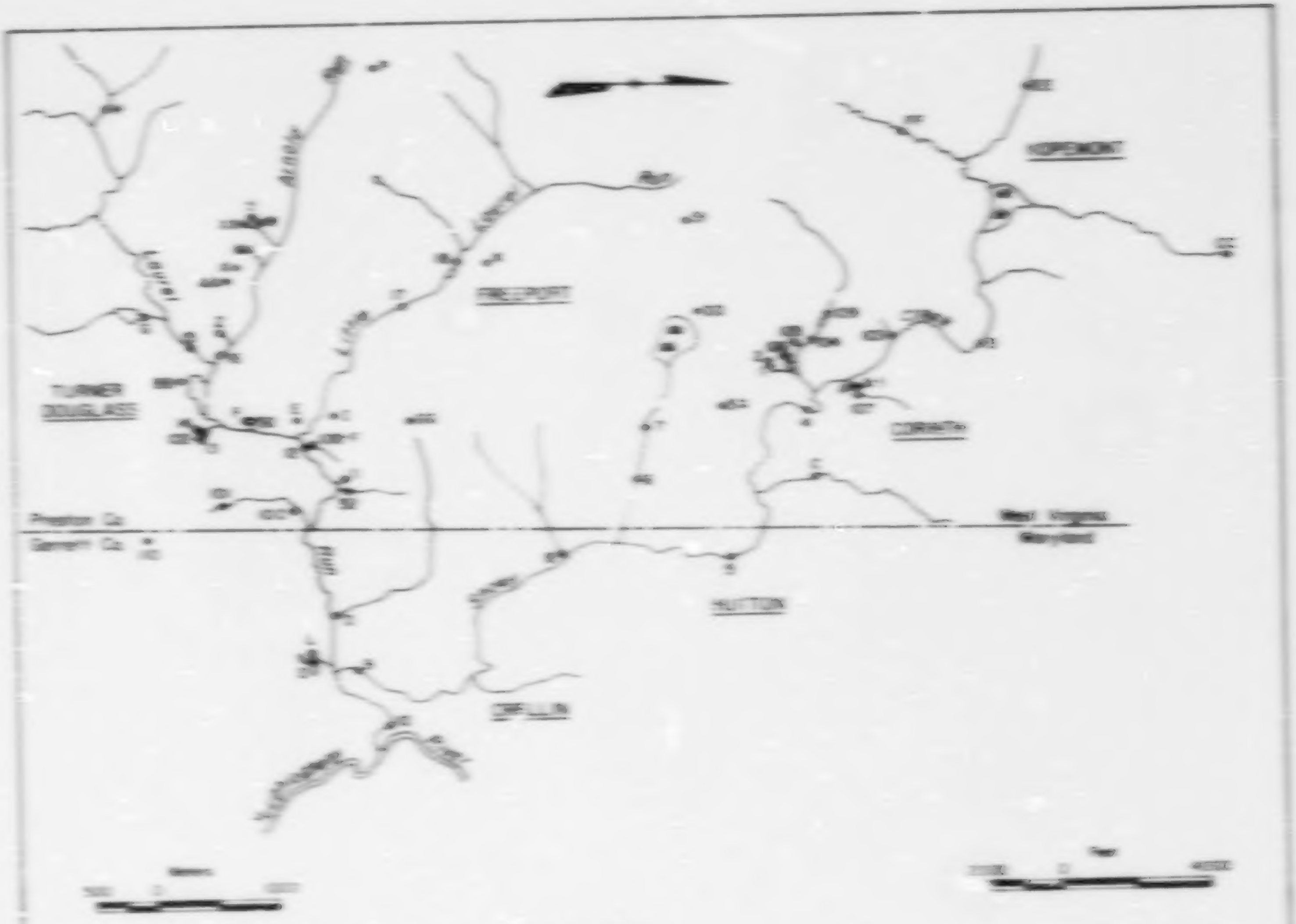

TURNER
DOUGLASS
Laurel
FREEPORT
HOPEMONT
CORINTH
HUTTON
CRELLIN
Run
Preston Co.
Garrett Co.
West Virginia
Maryland
Meters
Feet

Figure 14. Snowy Creek–Laurel Run stream sample locations.

established at each major stream section, and a gaging system was developed. Data were collected for approximately 5 months at these stations, and stage-discharge curves were plotted. Periodically the stage-discharge curves were checked and revised as necessary. Flows obtained at the mouth of Snowy Creek were correlated with the nearest U.S. Geological Survey gage (number 03075500) on the Youghiogheny River. Details of this correlation are presented later in this section under Hydrology.

Measurement of some discharges was obtained using a V-notch weir. These weirs were installed with the 45° bevel facing upstream as shown in Figure 15. This modified construction has been found to pass more flow at lower heads than a standard V-notch weir.[9] The modified design also provides better nappe separation for monitoring low flows. The comparison of the modified construction curve with the standard construction curve is seen on Figure 16. The modified weirs were calibrated using a bucket and stop watch to measure the weight of water over the weir in a given amount of time. Plotting the relationship of head over the weir and discharge yielded a weir calibration curve.

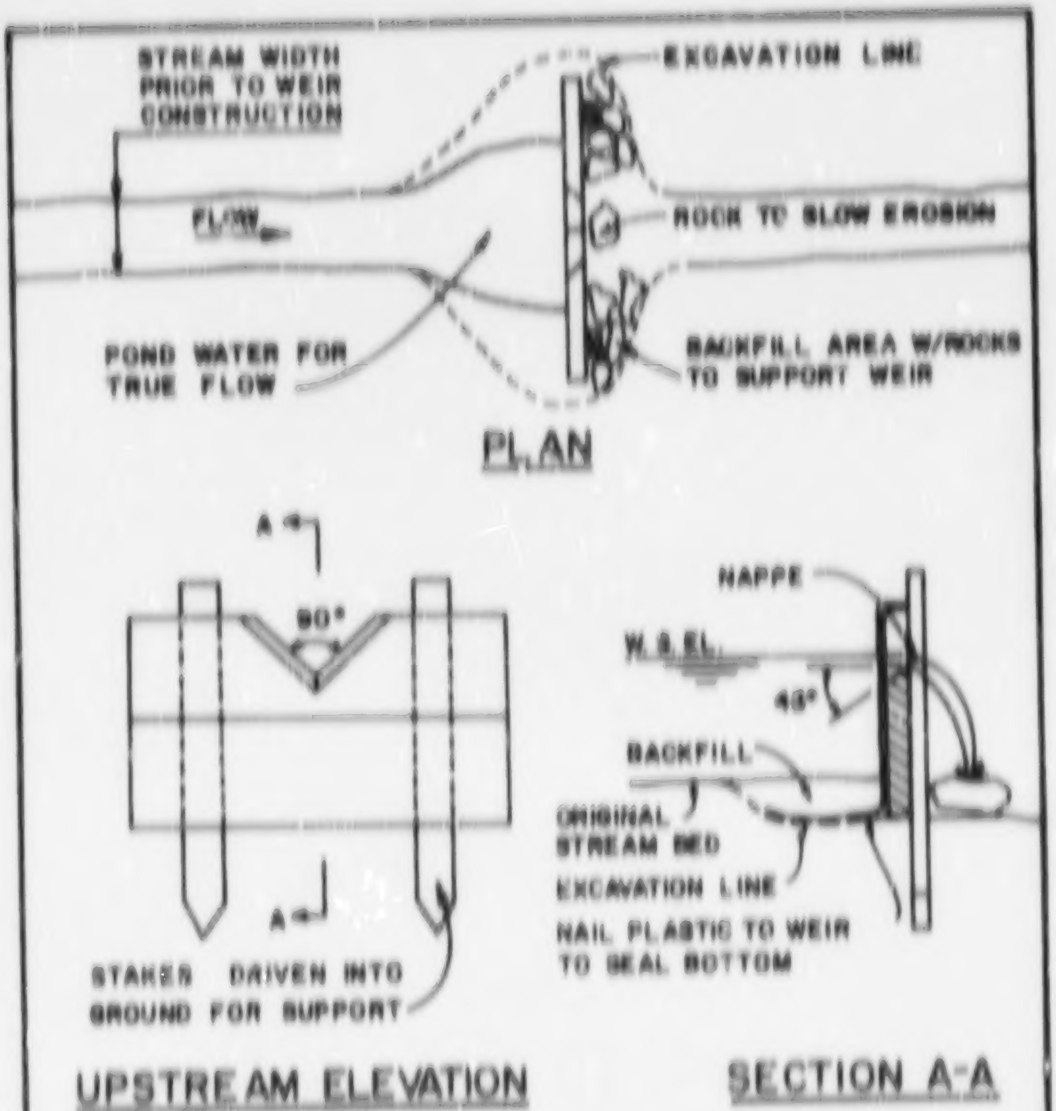
A continuous monitoring station was also constructed at the mouth of Snowy Creek just above its confluence with the Youghiogheny River. The station is at the Underwood Road Bridge about a fourth of a mile south of Crellin, Maryland. A monitoring unit recording pH and specific conductance on a continuous basis was installed. Figure 17 is a plan of the installation of the monitoring equipment. A stilling well for the station was constructed as shown in Figure 18 to allow the use of a Stevens A-35 stage level recorder. Data collected at this station were used primarily to complement the laboratory analyses and to check flow measurements of unrecorded extremes that might have occurred during the sampling program.

Sampling Program Results

To tabulate and analyze the large quantity of sampling data generated, two computer programs were prepared for use on General Automations Computer Model 18-30. The first Acid Mine Drainage Metric Version (AMDMV) was developed to express output in metric format. The second Acid Mine Drainage English Version (AMDEV) was prepared to express data in English format.

Sample information collected was continuously summarized on a sample run or individual sample location basis. The results of the sampling program are presented in AMDMV format in Appendix C. Appendix C is divided into three types of sample summaries: major sample locations, supplementary (grab) samples and comprehensive water quality analysis summaries. Sample locations are identified as a four digit character such as 0017. The zeros preceding alpha or numeric characters are dropped in subsequent text references (0017 is reported as 17).

Graphic presentation of flow data collected is outlined in Figure 19. Sample stations of weekly or bi-weekly importance are presented in this figure and in following distribution diagrams. Data presented in Figure 19 indicates that the mean discharge for the Snowy Creek Basin was 128.2 m^3/min (75.5 cfs) as measured at Station 10. Sixty-eight percent or 86.6


STREAM WIDTH PRIOR TO WEIR CONSTRUCTION
EXCAVATION LINE
FLOW
ROCK TO SLOW EROSION
POND WATER FOR TRUE FLOW
BACKFILL AREA W/ROCKS TO SUPPORT WEIR
PLAN
A
90°
A
STAKES DRIVEN INTO GROUND FOR SUPPORT
NAPPE
W.S.EL.
45°
BACKFILL
ORIGINAL STREAM BED
EXCAVATION LINE
NAIL PLASTIC TO WEIR TO SEAL BOTTOM
UPSTREAM ELEVATION
SECTION A-A

NOTE: BEVELED EDGE OF WEIR FACES UPSTREAM TO ALLOW NAPPE TO SPRING FREE OF WEIR, MAKING SMALL FLOW MEASUREMENTS MORE ACCURATE. A FLOW CURVE IS THEN DEVELOPED BY PLOTTING MEASURED HEAD VS MEASURED POUNDS OF WATER PER SECOND.

(NO SCALE)

Figure 15. V-notch weir used to measure small flows.

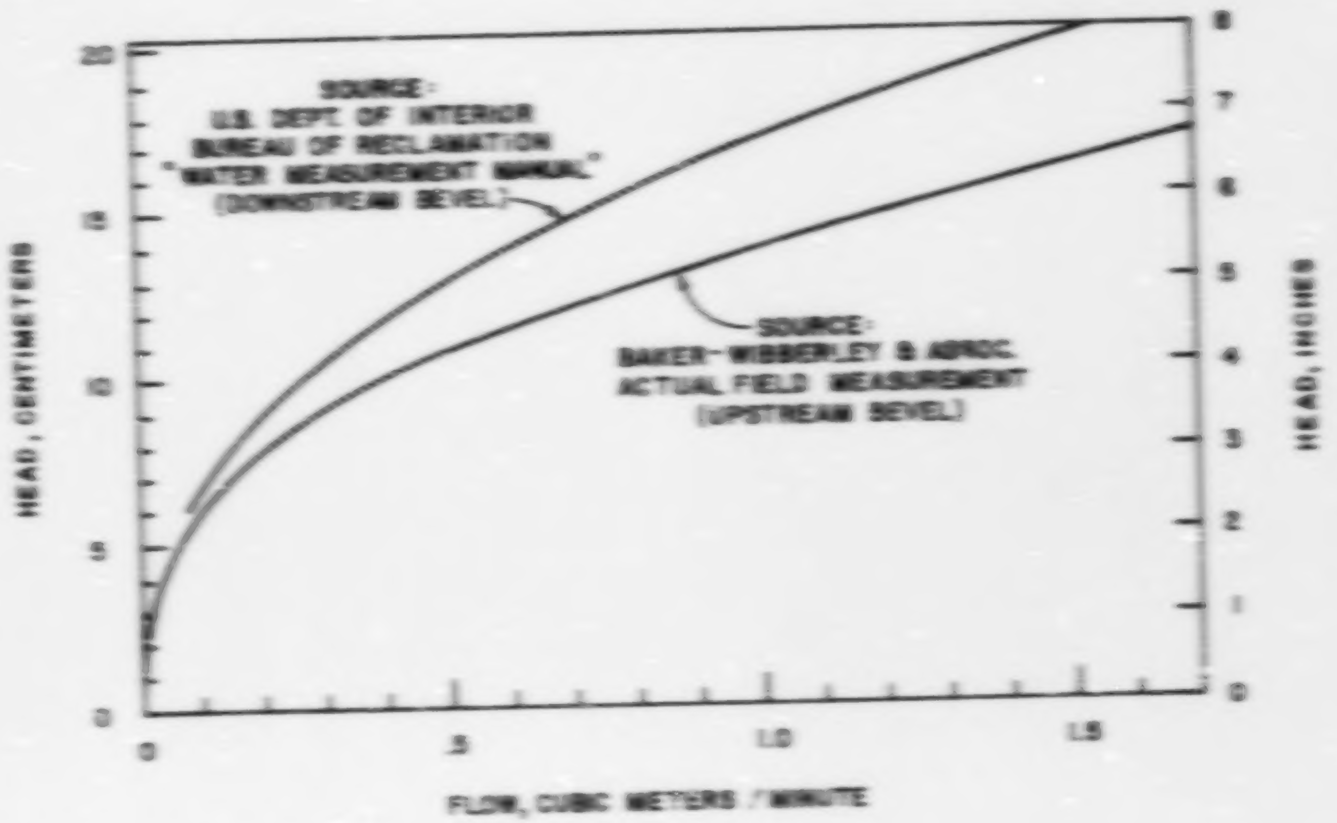


Figure 16. Comparison of 90° V-notch weir curve—upstream bevel vs downstream bevel.

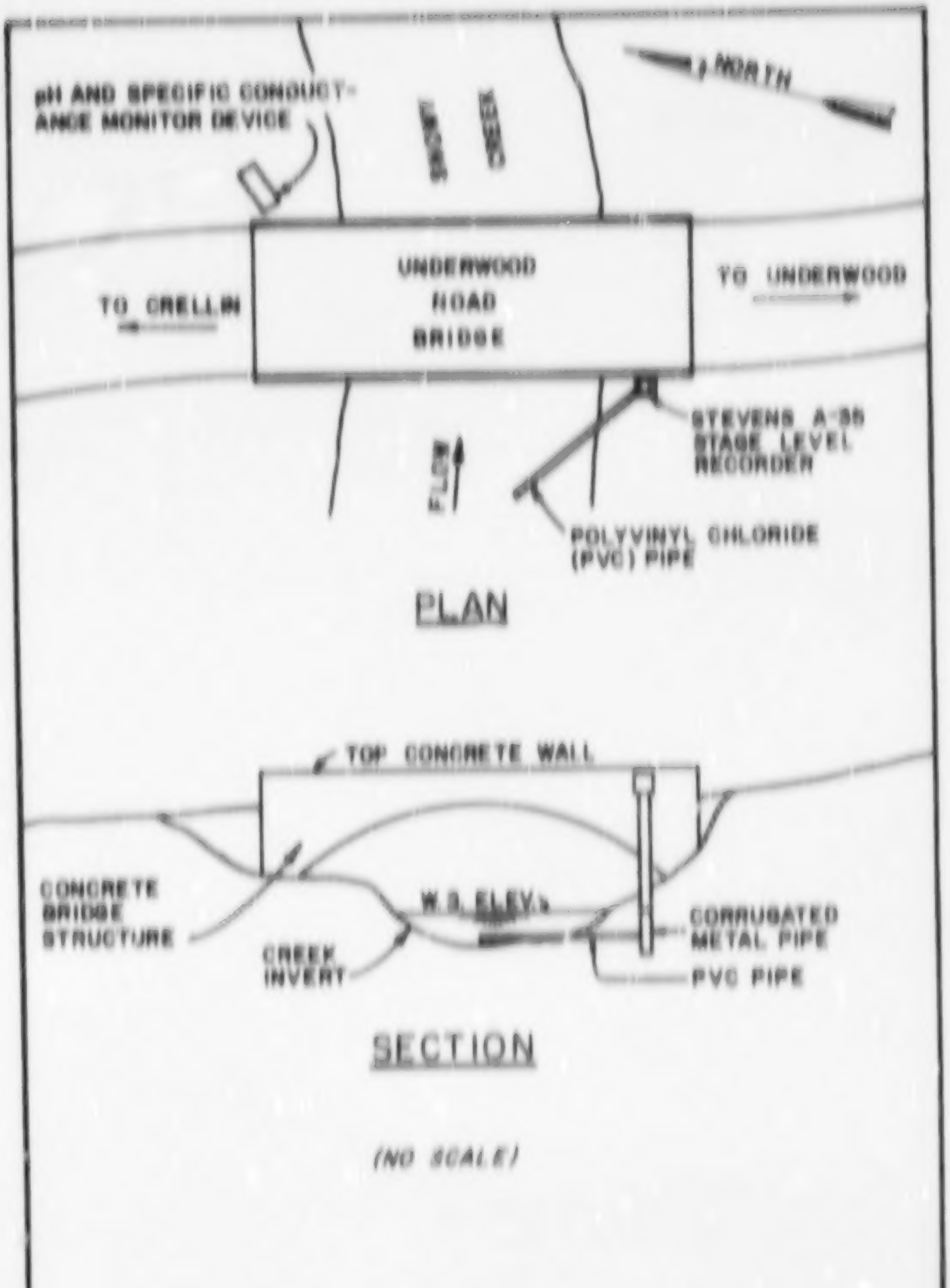

pH AND SPECIFIC CONDUCTANCE MONITOR DEVICE
SNOWY CREEK
NORTH
UNDERWOOD ROAD BRIDGE
TO CRELLIN
TO UNDERWOOD
STEVENS A-35 STAGE LEVEL RECORDER
FLOW
POLYVINYL CHLORIDE (PVC) PIPE
PLAN
TOP CONCRETE WALL
CONCRETE BRIDGE STRUCTURE
W.S. ELEV.
CORRUGATED METAL PIPE
CREEK INVERT
PVC PIPE
SECTION
(NO SCALE)

Figure 17. Location of Snowy Creek continuous monitor.

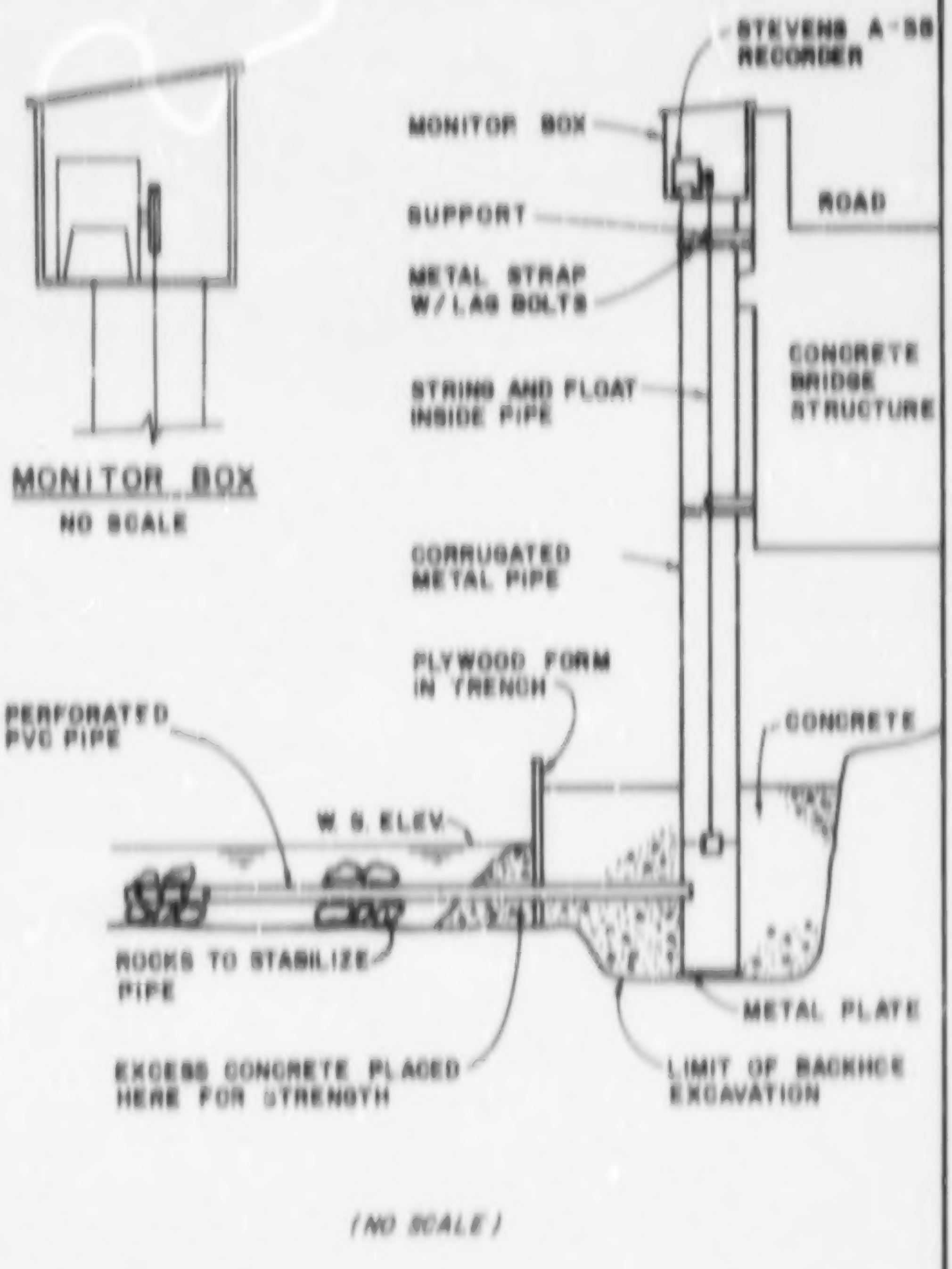
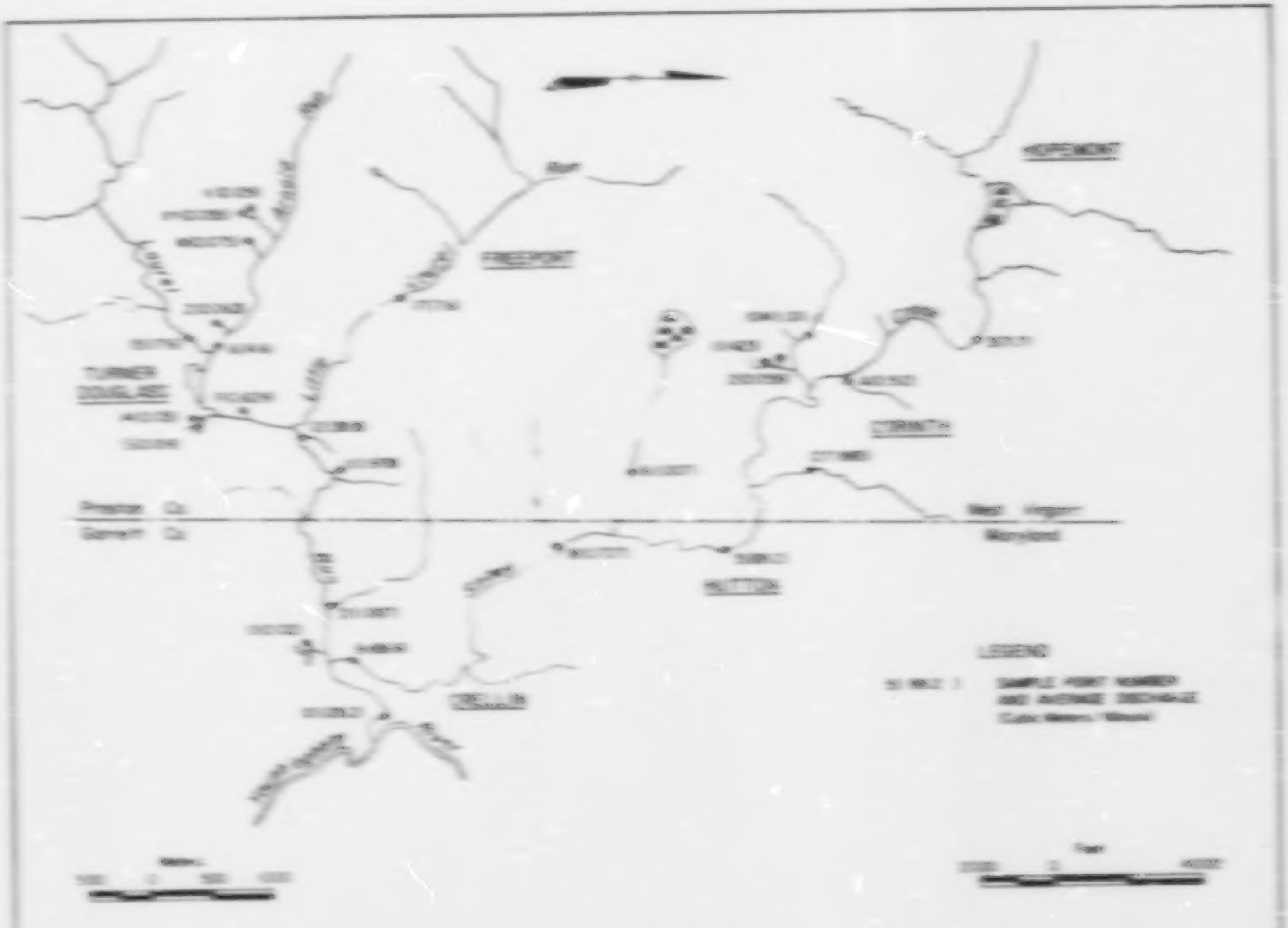

STEVENS A-35
RECORDER
MONITOR BOX
SUPPORT
ROAD
METAL STRAP
W/LAG BOLTS
CONCRETE
BRIDGE
STRUCTURE
STRING AND FLOAT
INSIDE PIPE
MONITOR BOX
NO SCALE
CORRUGATED
METAL PIPE
PLYWOOD FORM
IN TRENCH
PERFORATED
PVC PIPE
CONCRETE
W. S. ELEV.
ROCKS TO STABILIZE
PIPE
METAL PLATE
EXCESS CONCRETE PLACED
HERE FOR STRENGTH
LIMIT OF BACKHOE
EXCAVATION
(NO SCALE)

Figure 18. Section of Snowy Creek stage level recorder.



HOPEMONT
FREEPORT
TURNER
DOUGLASS
CORINTH
HUTTON
Preston Co.
Garrett Co.
West Virginia
Maryland
LEGEND
SAMPLE POINT NUMBER
AND AVERAGE DISCHARGE
Meters
Feet

Figure 19. Mean flow distribution in the Snowy Creek–Laurel Run basin.

m^3/min (51 cfs) of this total is referable to the portion of the basin drained by Snowy Creek and is measured at Station 9. The remaining 41.6 m^3/min (24.5 cfs) is contributed by that portion of the basin drained by Laurel Run. Average flow measured at Station 3 was 71.7 m^3/min (42.2 cfs) or 56 percent of the total basin flow. Station 3 monitors water quality just above the first acid mine drainage discharge into Snowy Creek. Laurel Run enters Snowy Creek between station 9 and station 10, just before Snowy Creek's confluence with the Youghiogheny River.

Sulfate loadings increase significantly as Snowy Creek enters areas of past or present mining activity. Figure 20 shows two significant increases. The first occurs between Stations 3 and 5, where loadings increase by 128 percent. This result is attributable to the Lima Mine, which is located between these two stations. The second noticeable increase occurs between Stations 9 and 10. An increase in loadings of 132 percent is directly related to the dumping of Laurel Run, which drains the Banner Mine area, into Snowy Creek.

Snowy Creek exhibited a marked net acidity throughout the lower half of the basin (see Figure 21). It has been determined that the only alkaline conditions found in the basin are located upstream of Station 3. Increased acidity occurs between Stations 3 and 5. Introduction of discharges from the Lima Mine area increased loadings from 4 kg/day (10 lb/day), measured at Station 3, to 1,902 kg/day (4,192 lb/day) measured at Station 5. No alkaline conditions were found in Laurel Run. Concentrations of natural acids plus large quantities of acid mine drainage from the Banner Mine complex are the sources of 54 percent of total acid loadings recorded at the mouth of Snowy Creek.

Sampling program results strongly indicate that the Lima and Banner Mine areas are the major sources of acid mine drainage found in the Snowy Creek - Laurel Run Basin.

Samples collected by the Maryland Water Resources Administration (WRA) between 1963 and 1970 indicated that the Youghiogheny River is severely degraded by acid mine drainage from the Snowy Creek Basin. WRA computed stream loadings based upon 1967 to 1970 data (12 sample collections). These calculations show the acid load from the Snowy Creek Basin to vary between 907 and 19,320 kg/day (2,000 and 42,600 lb/day) with an average daily load of 1,364 to 1,814 kg/day (3,000 to 4,000 lb/day) being discharged to the Youghiogheny River.[6]

Grab samples taken during the last half of this study sampling program show the Youghiogheny River above Snowy Creek to be alkaline and below its confluence with Snowy Creek to be acidic.

Routine samples collected (38 samples) at the mouth of Snowy Creek (Station 10) during this study, show the acid load contributed by Snowy Creek to the Youghiogheny River ranged between 639 and 25,604 kg/day (1,409 and 56,457 lb/day) with a mean value of 4,663 kg/day (10,282 lb/day).

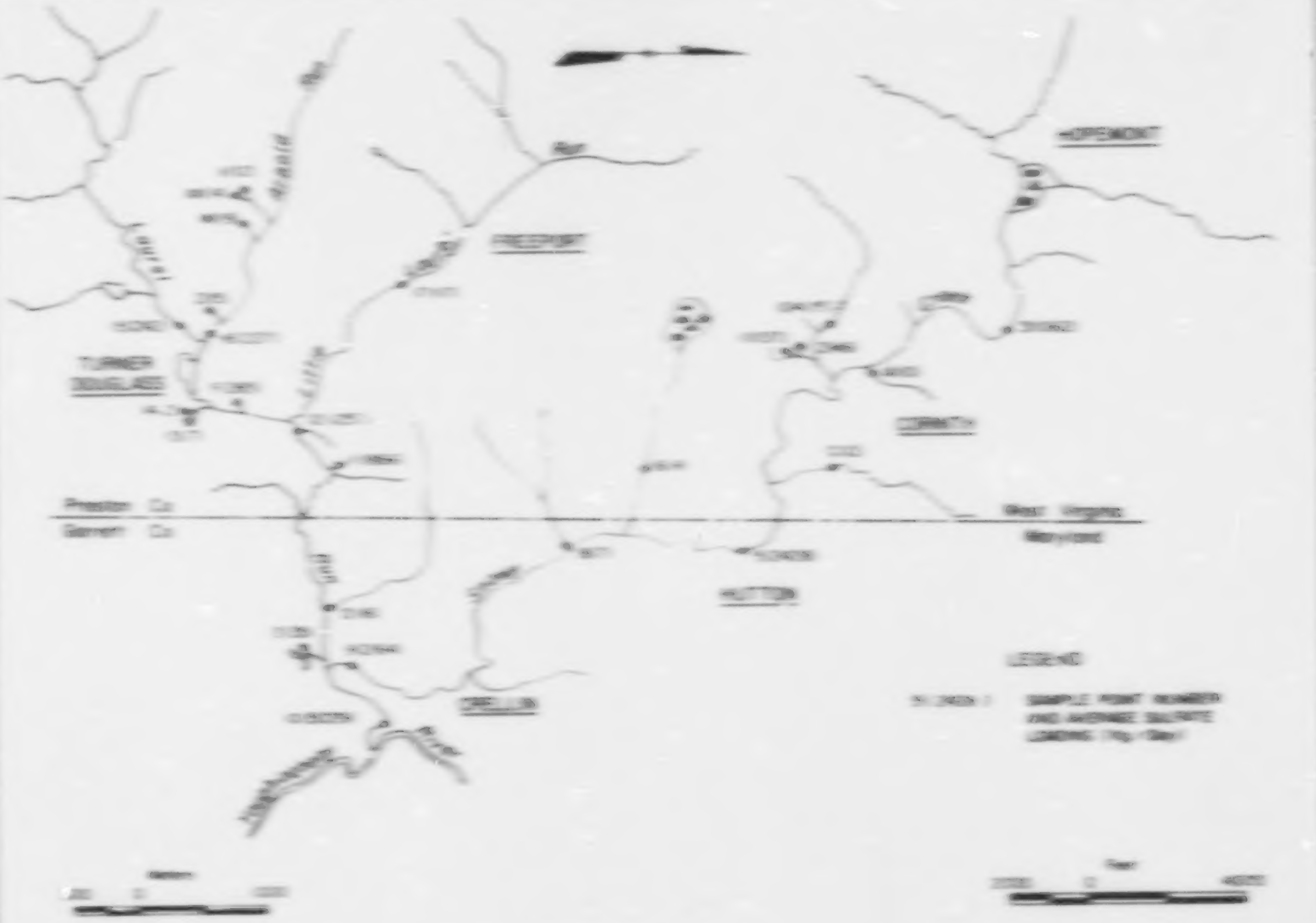

HOPEMONT
FREEPORT
TURNER
DOUGLASS
CORINTH
HUTTON
ORELLA
Laurel
Run
Little
Preston Co.
Garrett Co.
West Virginia
Maryland
LEGEND
SAMPLE POINT NUMBER
AND AVERAGE SULFATE
LOADING (Kg/Day)
Meters
Feet
2000
0
4000

Figure 20. Mean sulfate loadings in the Stoney Creek-Laurel Run basin.

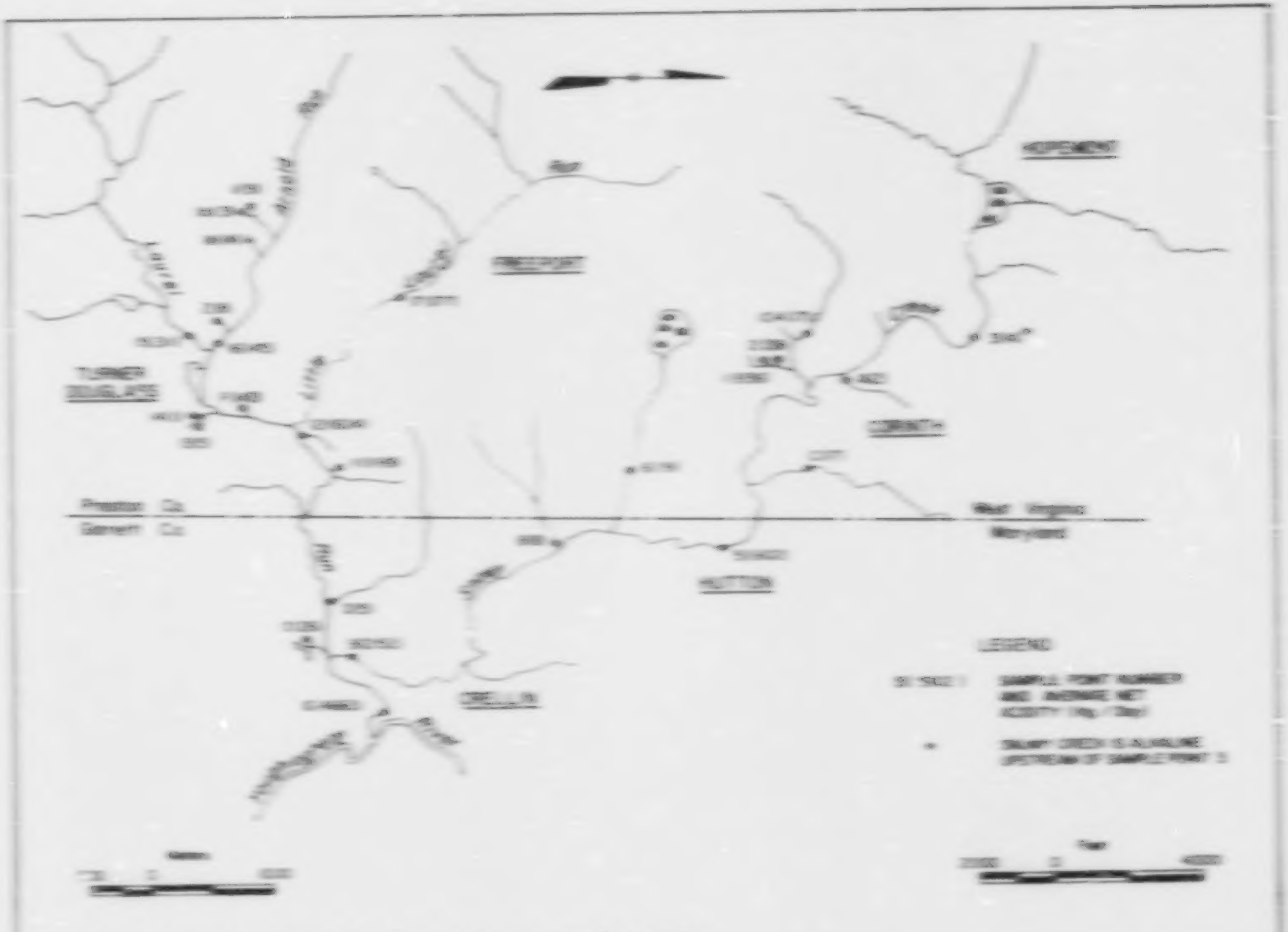

HOPEMONT
FREEPORT
Run
Arnold
Laurel
TURNER
DOUGLASS
Little
CORINTH
Preston Co.
Garrett Co.
West Virginia
Maryland
HUTTON
CRELLIN
LEGEND
SAMPLE POINT NUMBER
AND AVERAGE NET
ACIDITY (kg./Day)
SNOWY CREEK IS ALKALINE
UPSTREAM OF SAMPLE POINT 3
Meters
Feet
2000
0
4000

Figure 21. Mean net acidity in the Snowy Creek–Laurel Run basin.

Hydrology

Flow measurements recorded at Station 10 near the mouth of Snowy Creek were correlated with the U.S. Geological Survey gage located on the Youghiogheny River near Oakland, Maryland.[7] Results of the 38 corresponding measurements are presented in Table 4. On each date that a flow measurement was recorded at Station 10, a corresponding flow measurement was obtained for the U.S. Geological Survey gage. The average flow recorded at Station 10, 128 m^3/min (75 cfs), is approximately 26 percent of the average flow, 488 m^3/min (287 cfs), recorded at the U.S. Geological Survey gage. The drainage area at Station 10 is 25 percent 88 km^2 (34 mi^2) of the drainage area 347 km^2 (134 mi^2) contributing to the U.S. Geological Survey gage.

TABLE 4. FLOW DATA EVALUATION

Date sampled	Snowy Creek[a] (m^3/min) cubic meter/minute	Youghiogheny River[b] (m^3/min) cubic meter/minute
May 28, 1975	77	275
June 11, 1975	83	230
June 24, 1975	36	105
July 7, 1975	61	194
July 21, 1975	75	105
August 4, 1975	27	54
August 18, 1975	296	1,170
September 2, 1975	468	1,499
September 16, 1975	66	143
September 29, 1975	83	362
October 13, 1975	95	248
October 27, 1975	77	216
November 10, 1975	44	104
November 17, 1975	82	233
November 24, 1975	66	155
December 1, 1975	63	148
December 8, 1975	87	209
December 15, 1975	139	469
December 22, 1975	99	308
December 29, 1975	136	432
January 5, 1976	309	1,204
January 12, 1976	92	394
January 19, 1976	116	332
January 26, 1976	207	1,244
Feburary 2, 1976	82	411
February 9, 1976	102	400
February 16, 1976	471	1,561
February 23, 1976	224	896
March 1, 1976	73	342

(continued)

TABLE 4 (continued)

Date sampled	Snowy Creek[a] (m^3/min) cubic meter/minute	Youghiogheny River[b] (m^3/min) cubic meter/minute
March 8, 1976	29	170
March 15, 1976	163	699
March 22, 1976	377	1,601
March 29, 1976	61	372
April 5, 1976	219	1,290
April 12, 1976	49	118
April 19, 1976	19	165
April 26, 1976	88	292
May 3, 1976	32	216
Total	4,873	18,546
Average	128	488

[a] Measured at Station 10. Drainage area 88 m^2 (34 in^2).

[b] Obtained at U.S. Geological Survey stream gauge. Drainage area 347 km^2 (134 mi^2).

This comparison has proven valuable for several reasons. First, it serves as a good check for indicating whether open channel flow measurements recorded during the sampling program are of reasonable accuracy. The fact that Snowy Creek does indeed contribute an average of 25 percent of the total flow as measured at the Youghiogheny stream gage can be further used on hydrographs to estimate high flows as recorded by the stage level recorder at the mouth of Snowy Creek.

High flows--those over 1,870 m^3/min (1,100 cfs)- as recorded at the Youghiogheny River gaging station for the sampling period are tabulated in Table 5. Dates included are those on which a recorded high flow could have been observed if a routine sample run had been scheduled. Using the 25-percent relationship, a corresponding estimated high flow could be interpolated to have occurred on Snowy Creek. The estimated highest flows probably occurred on January 1, 1976.

Based on historical records at the U.S. Geological Survey gage, Table 6 estimates the magnitude of peak flows and suggested return frequencies of historical floods applicable to Snowy Creek.[8]

Finally, utilization of the 25-percent relationship has developed a quick and accurate method of determining flows on Snowy Creek. Ease of measurement of the estimated flows will be of great value in future monitoring programs on the Snowy Creek - Laurel Run Basin.

TABLE 5. RECORDED HIGH FLOWS

Date of occurrence	U.S. Geological Survey* measured flow m^3/min
August 16, 1975	2,756
August 17, 1975	2,312
August 23, 1975	2,611
August 24, 1975	2,278
December 31, 1975	2,261
January 1, 1976	5,287
January 2, 1976	2,567
January 3, 1976	1,887
February 11, 1976	2,788
February 12, 1976	2,057
February 14, 1976	2,193
February 17, 1976	1,972
February 18, 1976	1,921

* Recorded peak flows not occuring on regular sample runs measured on the Youghiogheny River.

TABLE 6. PEAK FLOWS

Return frequency	Peak U.S. Geological Survey gauge	Estimated Peak* Snowy Creek (m^3/min)
2-year	7,361	1,840
5-year	11,271	2,818
10-year	14,161	3,540
25-year	18,190	4,548
50-year	21,250	5,313
100-year	24,140	6,035

* Peak based on a contribution from Snowy Creek of 25 percent of total flow to the U.S. Geological Survey gage.

SOCIAL AND ECONOMIC ENVIRONMENT

Population trends in Preston County have generally reflected the trend of decline in the State's population. A 7-percent decline was recorded from 1960 to 1970 according to published census data. Since 1970 however, there has been an increase of 5-percent in Preston County's population.[9]

The largest town, Kingwood, had a population of 2,550 in 1970. The largest town in the Snowy Creek basin is Terra Alta, with an estimated 1970 population of 1,600.

Major economic activities in Preston County and the Snowy Creek Basin are limited to forestry, agriculture, and mining. At present, probably 50 percent of the county is covered by forest. The forest products industry, however, is still very small. Agricultural activities are primarily limited to small beef and dairy farms. Mining and related industries are major employers in Preston County.[10] As of October 1975, Preston County had more active strip mines than any other county in West Virginia. Because the county is in a mountainous region, tourism may be an important economic contribution for the future. At present there are two State Parks, Cooper's Rock and Cathedral.

Water requirements in the Snowy Creek basin are at present very small. The largest town, Terra Alta, has its own reservoir to supply present and future needs. Downstream on the Youghiogheny River, the town of Oakland, Maryland, uses an average of 980 m^3/day (259,000 gal/day) to supplement its public water supply. Surface water use for recreational purposes is also very limited, primarily due to existing substandard quality caused by acid mine drainage.

In the event that the Youghiogheny River becomes a part of the National Wild and Scenic River System, recreation possibilities and tourism will increase in the area. The State of Maryland has already classified the Youghiogheny River as a member of the State Scenic River System. Garrett County, Maryland, according to its development plan, has already established the Maryland sections of the Youghiogheny River, Snowy Creek, and Laurel Run as areas to be utilized for "open space" and "public recreation" needs. Therefore, proposed abatement in the Snowy Creek basin would increase recreational possibilities for both Preston County, West Virginia, and Garrett County, Maryland.[11]

SECTION 6

PRELIMINARY ENGINEERING

ABATEMENT METHOD DESCRIPTION

Only 30 percent of the Snowy Creek - Laurel Run Basin is affected by acid mine drainage. Two large pollution sources are responsible for 88 percent of the total acid load discharged from the basin. The two areas, the Lima Mine and the Banner Mine, are the prime targets of major abatement projects as outlined in this study.

Abatement designs in the report have therefore been developed to handle these major pollution sources. Other areas in the study basin exhibit some mine drainage problems, but when compared with the amount of acid mine drainage loadings of the Banner and Lima Mines, their impact on Snowy Creek is negligible.

The most effective abatement measure for the Snowy Creek Basin was determined to be a plan that eliminated the more significant problem areas.

The abatement plans are essentially two separate designs for two individual problem areas. Each design relies on implementation of the other to achieve a total of 75 percent or higher abatement for the Snowy Creek basin. Each design will stand by itself, achieving a percentage of the abatement plan total.

The basic concept of both abatement designs is to inundate additional deep mine workings in the Banner and Lima Mines. With inundation at higher levels, available oxygen will be prevented from reacting with a large amount of acid-producing material, and the circulation and internal mixing that is now present will be eliminated once the mine pools have been stabilized.

Inundation at the Lima Mine should be accomplished by the use of a continuous clay core dam. The Banner Mine will be flooded using an earth dam to create a mine pool level control lake.

Depending on the condition of the barrier remaining between the Lima and Banner Mines, the continuous clay core dam may require extension or reduction in the Freeport area.

PRELIMINARY DESIGN

The Lima Mine Abatement Plan

Presently, only 14 percent of the Lima Mine is flooded. The main discharge point, at an elevation of 743 m (2,438 ft) delineates an approximate shoreline of the present mine pool. The existing mine pool is controlled by the elevation of the existing outfall. Water quality at the main discharge point is not within the acceptable standards for mine drainage discharges as established by the West Virginia Department of Natural Resources.

Data obtained during the sampling period at Station 1, the main discharge point for the Lima Mine, indicate an average flow of 1,423 m^3/min (0.837 cfs), an average acid concentration of 457 mg/l, and an average loading of 936 kg/day (2,063 lb/day).

According to stream balances Snowy Creek is alkaline above the Lima Mine area as measured at Sample Station No. 3. There is no acid mine drainage above this point. Once Snowy Creek enteres the Lima Mine area it now becomes an acidic stream picking up approximately 1,859 kg/day (4,099 lb/day). Detailed sample analyses are found in Appendix C.

It has been concluded that the only sources of acid mine drainage entering Snowy Creek upstream from Laurel Run are those in the Lima Mine area. Loadings attributable to this area account for 86 percent of the Snowy Creek total acid load above Laurel Run.

The Design--
The abatement design proposed for the Lima Mine employs a continuous clay core dam to be constructed around the perimeter of old deep workings to an elevation of 772 m (2,532 ft). The clay core will function as an inverted dam with further inundation of the old deep workings. Figure 22 illustrates the role of the continuous clay core dam. The shaded area between the shoreline of the existing mine pool at an approximate elevation of 743 m (2,438 ft) and the shoreline of the proposed mine pool at an approximate elevation of 772 m (2,532 ft) represents the additional deep mine workings to be flooded by the abatement plan. The clay core dam will function both as a mine seal and an artifical barrier to separate mine water.

Excavation to install the continuous clay core dam would be accomplished in much the same manner as excavation to remove the overburden in a stripping operation. A single box cut would be taken along the perimeter of the deep-mine workings, exposing both the coal seam and related workings. Excavation at the southern perimeter (Freeport side) would resemble a large trench. On the northern perimeter (Corinth side), the eastern half of the box cut would also be a large trench, with the western side excavated in the form of an open-sided pit.

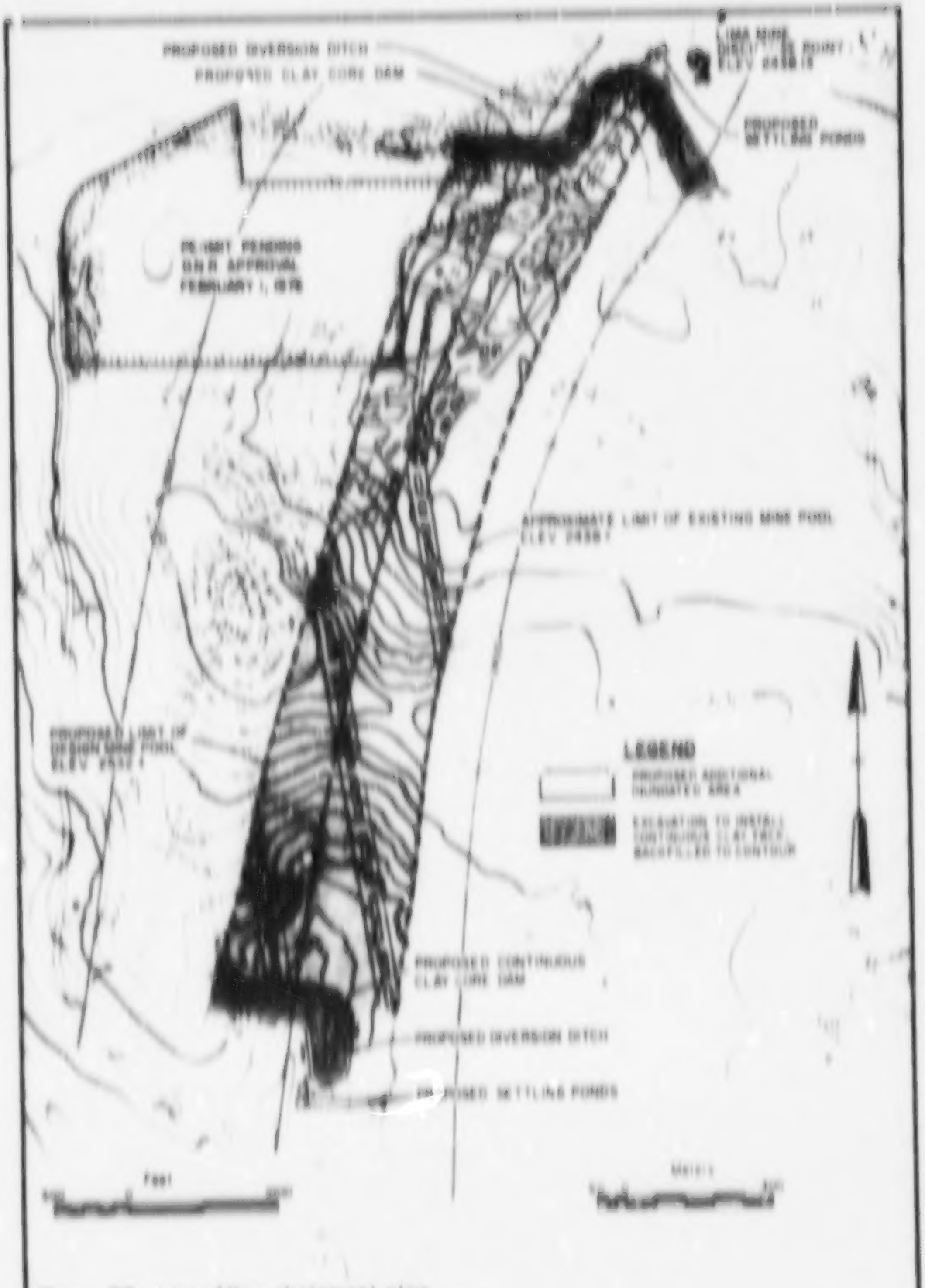

PROPOSED DIVERSION DITCH
PROPOSED CLAY CORE DAM
LIMA MINE DISCHARGE POINT
PROPOSED SETTLING PONDS
PROJECT PENDING D.N.R. APPROVAL FEBRUARY 1, 1978
APPROXIMATE LIMIT OF EXISTING MINE POOL
PROPOSED LIMIT OF DESIGN MINE POOL
LEGEND
PROPOSED ADDITIONAL INUNDATED AREA
EXCAVATION TO INSTALL CONTINUOUS CLAY PACK BACKFILLED TO CONTOUR
PROPOSED CONTINUOUS CLAY CORE DAM
PROPOSED DIVERSION DITCH
PROPOSED SETTLING PONDS
Feet
Meters

Figure 22. Lima Mine abatement plan

Once the earthwork has been completed and the removal of the coal accomplished, the compacted clay core can be constructed as illustrated in Figure 23 and Figure 24. Figure 24 indicates the trenching excavation that will be required to install the clay core on the Freeport side and on the eastern half of the Corinth side. The remaining earthwork configuration will resemble Figure 23.

Installation of a continuous clay core is critical for the proposed abatement plan. In areas where old deep mine workings are encountered, the openings should be packed with impervious material to a minimum of three times the widest opening. The clay core should also be compacted along the entire length of the exposed highwall. The continuous clay core should be at least 3.05 m (10 ft) above the top seam of coal. Figures 23 and 24 indicate the configuration of the proposed clay core.

The clay to be used in the core will be found locally and will be encountered in the excavation for the seal. The clay was sampled and tested by Pittsburgh Testing Laboratory, Pittsburgh, Pennsylvania, and was found to have a permeability of 6.869 x 10^{-7} cm/sec. The permeability of this local clay is considered suitable for use in the clay core dam.

Backfilling will begin once the seal has been installed and will approximate the original contour. The area should be fertilized, mulched and seeded in accordance with recommendations of the U.S. Soil Conservation Service and the West Virginia Department of Natural Resources. Tentatively, a mixture of weeping lovegrass, birdsfoot trefoil, and Kentucky 31 tall fescue is suggested.

It has been determined that the active stripping operation will reclaim the area adjacent to the proposed clay core dam. Old mine workings and mine dumps will be regraded and revegetated as a part of their present permit.

Conclusions--

Once the clay core dam has been completed it will function in two ways. First, additional flooding of the Lima Mine will inundate approximately 36 percent more of the workings now producing acid mine drainage. Second, the clay core will act as a diversion dam, diverting runoff from the active workings away from the old deep workings. Active surface operations could extract coal above the shoreline of the design mine pool at an elevation of 772 m (2,532 ft). If new stripping permits are issued specifications and requirements to continue the clay core around the perimeter of the design mine pool must be added on all first cuts and on all down-dip ends of the operation joining existing successive segments of the clay core.

If future mining is permitted, eventually the coal and mine workings near the top of the hill above a structure contour of 772 m (2,532 ft) would be daylighted. The recovery of a valuable resource will then be accomplished, and total abatement of the Lima Mine completed.

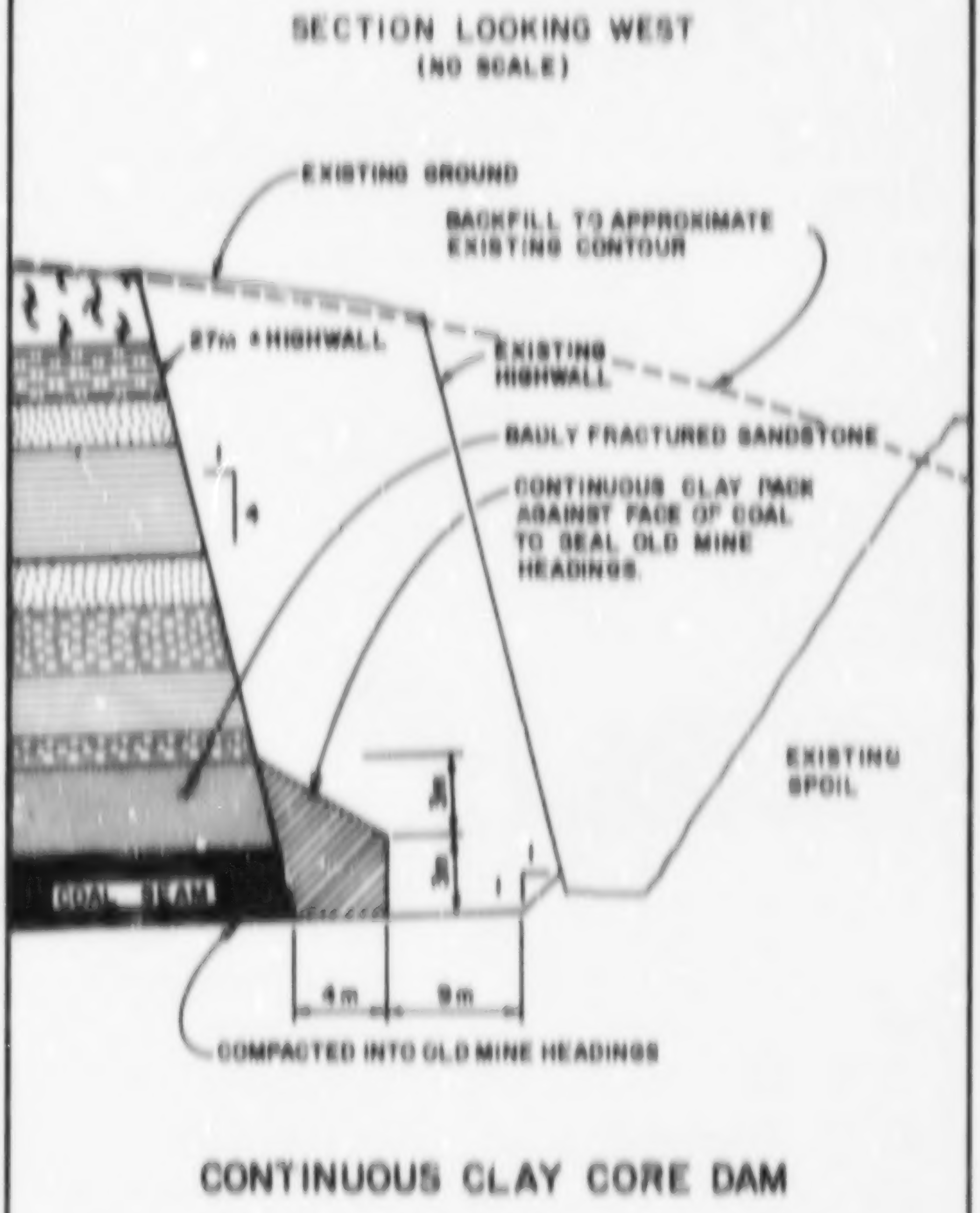
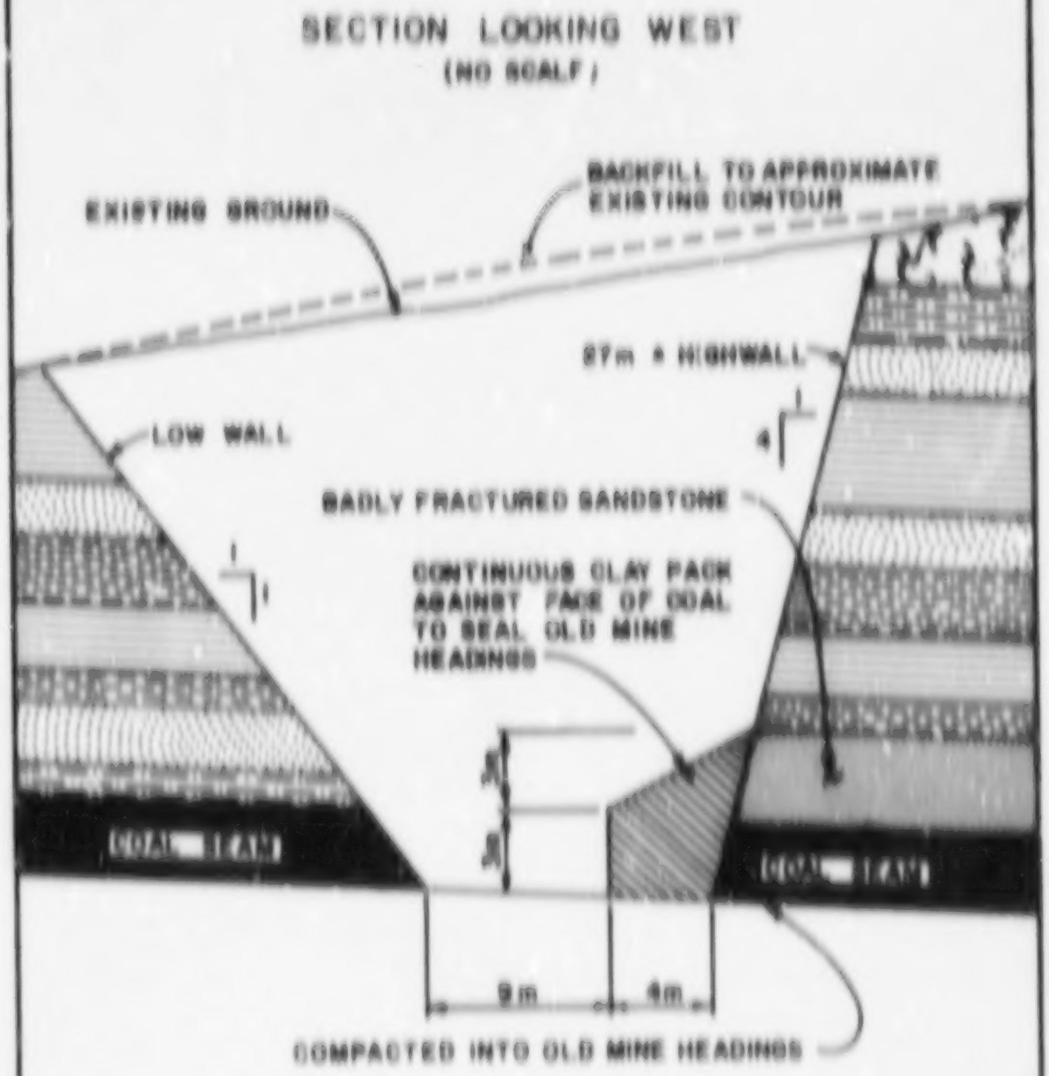

SECTION LOOKING WEST
(NO SCALE)
EXISTING GROUND
BACKFILL TO APPROXIMATE EXISTING CONTOUR
27m ± HIGHWALL
EXISTING HIGHWALL
BADLY FRACTURED SANDSTONE
1
4
CONTINUOUS CLAY PACK AGAINST FACE OF COAL TO SEAL OLD MINE HEADINGS.
3m
3m
1
1
EXISTING SPOIL
COAL SEAM
4m
9m
COMPACTED INTO OLD MINE HEADINGS
CONTINUOUS CLAY CORE DAM

Figure 23. Lime Mine abatement plan — Corinth section.


SECTION LOOKING WEST
(NO SCALE)
BACKFILL TO APPROXIMATE EXISTING CONTOUR
EXISTING GROUND
27m ± HIGHWALL
LOW WALL
4
1
1
1
BADLY FRACTURED SANDSTONE
CONTINUOUS CLAY PACK AGAINST FACE OF COAL TO SEAL OLD MINE HEADINGS
3m
3m
COAL SEAM
COAL SEAM
9m
4m
COMPACTED INTO OLD MINE HEADINGS

CONTINUOUS CLAY CORE DAM

Eastern portion of Corinth side will also be excavated using this trench detail

Figure 24. Lima Mine abatement plan – Freeport section.

Failure of the proposed clay core dams is remote. Trench section excavation (Figure 24) will be restrained by the 18 to 24 m (60 to 80 ft) height of the backfill material placed between the undisturbed trench walls. Adjacent to the active surface mine (Figure 23) the clay core dam will be restrained by the 18 to 24 m (60 to 80 ft) of the backfill material placed between the highwall and the existing spoil. Also the minimum width (to original contour) of existing restraining spoil will be approximately 75 m (246 ft) perpendicular to the highwall.

Clay core dams as proposed herein have been used by the mining industry in Pennsylvania for many years. In Somerset County, Pennsylvania the Gleasner Mines, Scurfield Coal Company Inc. and Croner Inc. have used this type of clay core dam for over eight years to separate and retain mine water. At the Gleasner Mines, the dams have been so successful that tracing agents would not pass through the cores. Scurfield Coal Company Inc. and Croner Inc., have used this type of clay core to seal off abandoned mine workings from their active surface mine operations and have had excellent success.

The Banner Mine Abatement Plan

The Banner Mine and its immediate area have been the principal source of acid mine drainage entering Snowy Creek.

Deep mining has caused many problems and has marred the landscape. At Turner Douglass, the location of the Banner Mine portal nearly 1,007,000 m³ (1,317,156 yd³) of mine waste, with a pH ranging from 3.0 to 3.5, apparently is a major source of acid production. Extensive subsidence resulting from the underground mining has created a swampy area of approximately 42.5 ha (105 acres). The existing swamp, with an elevation of slightly less than 732 m (2,400 ft), is located atop the existing mine pool which has an approximate elevation of 729 m (2,393 ft). Laurel Run, which drains this section of the Snowy Creek basin, meanders through the mine waste and swamp only a few feet above the mine pool.

A series of boreholes drilled when the Banner Mine was in production was used to dewater the mine. Today, with partial inundation of the deep mine, an artesian discharge exists at one of the holes. The borehole is located near the Maryland-West Virginia border and is presently dumping highly acidic waters of the mine pool into Laurel Run after circulation through workings and the mine pool to a depth of about 45 m (148 ft). The deep circulation prohibits stabilization of the pool. This borehole controls the level of the existing mine pool. Earlier attempts to seal this discharge were not successful.

Based on water quality data obtained during the sampling program the Banner Mine can be held responsible for approximately 2,169 kg/day (4,772 lb/day) of acid production. This total was derived by subtracting loadings coming into the Banner Mine complex at Stations 13, 14, 15, 16 and 17 from Station 12. This total is then assumed to be the acid load picked up by

Laurel Run as it passes through the Banner Mine area. Addition of the borehole discharge at Station 11, which is below 12, yields the probable total loading created by the Banner Mine area. Detailed sample analyses for these stations can be found in Appendix C.

There are several additional, but minor, acid mine discharges in the Freeport - Turner Douglass area. These minor discharges are located in the Arnold Run, Freeport, and Kildow mine areas. These discharges are extremely small when compared to the discharges of the Banner Mine complex.

The Arnold Run area at present contributes approximately 145 kg/day (319 lb/day) of acidity, which was measured at Station 16. Actual loadings in the Freeport area were not ascertained, but acid mine drainage discharges are very minor. Loadings created are primarily in response to surface runoff over the mine waste. The problem here is the need for aesthetic improvement. The two openings of the Kildow Mine were monitored at Stations 13 and 14. An average loading of 5 kg/day (11 lb/day) was recorded at Station 13 and an average loading of 1 kg/day (2.2 lb/day) was recorded at Station 14.

The prime goal of the abatement project for the Banner Mine and other outlying areas is a plan that will include elimination of pollution from significant quantities of surface mine waste, sealing of boreholes, negation of the effects of subsidence, closing of mine entries, rechannelization, channel lining, regrading, and revegetation. The proposed abatement design will handle the above problem areas quite adequately.

The Design--

To achieve any significant abatement at the Banner Mine the mine pool had to be raised first so that it could stabilize. Conventional designs employing curtain grouting and borehole sealing could be expected to have only limited success in the area that has a present mine pool only a few feet beneath the surface. As a consequence, a mine pool level control lake, employing an earth dam, was developed.

The plan would be to construct an earth-filled dam that would create an impoundment area situated immediately over the existing mine pool. The new impoundment would now become the surface control for the proposed mine pool levels. Flooding the area to an elevation of 750 m (2,460 ft) would eliminate about 90 percent of the Laurel Run acid mine drainage problem.

This proposed impoundment then eliminates the need for the conventional abatement methods of rechanneling, lining, sealing boreholes, curtain grouting subsidence areas, removing and burying mine waste, regrading, and revegetation. These traditional techniques include a measure of risk. The approach employing the earth dam ensures a higher percentage of abatement for the total project and removes areas of doubtful success.

The earth dam would be placed at a strategic narrow site in the Laurel Run Valley about 0.8 km (1.3 miles) into Maryland. Based on mine maps it is concluded that no underground mining will be encountered at the proposed dam site. However, as in any project such as this, a detailed subsurface exploration will be required during engineering design. The actual location of the dam and the associated impoundment can be seen in detail in Figure 25. The line indicating a topographic contour of 750 m (2,460 ft) will be the shoreline or extent of the mine pool level control lake. The shaded area inside a structure contour of 750 m (2,460 ft) indicates the subsurface flooding that will be accomplished by the impoundment. Seventy-four percent of the Banner Mine and adjacent workings will be inundated by flooding to an elevation of 750 m (2,460 ft).

A number of criteria were considered in selecting the design elevation of the proposed mine pool. It was determined that the proposed Lime Mine pool limits be established at a higher elevation than the Banner Mine pool. By elevating the present mine pools there will be no adverse effects on local ground water supplies due to the perched water table found in the basin. The design pool at the Lime Mine can be raised to approximately 772 m (2,532 ft) and the Banner Mine pool is designed to an elevation of 750 m (2,460 ft). There is a possibility that the two mines might be interconnected at some elevation above 743 m (2,438 ft).

An elevation of 750 m (2,460 ft) was selected as the maximum lake elevation that could be justified by the size of the contributing watershed. This elevation will not endanger the existing mill owned by the F.C. Grimm Lumber Company.

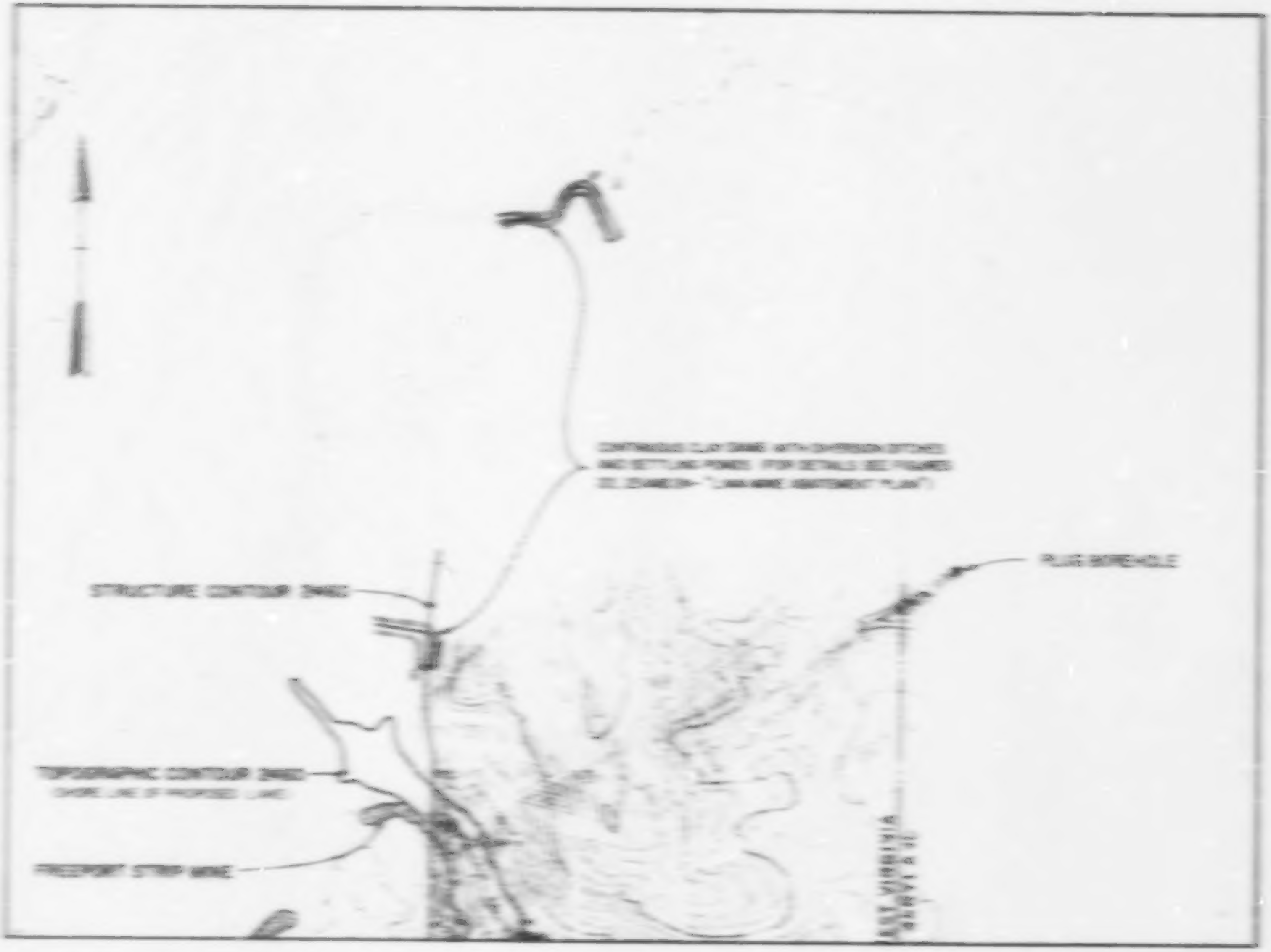
In flooding the Turner Douglass area, only limited amounts of personal property are required. There are only 13 houses located in the impoundment area, most of which are low-cost homes.

The proposed impoundment limits access for only a few persons. An access road and right-of-way has been included as part of the abatement project to service properties whose present access would be lost by the lake.

The construction of an earth dam (Figure 26) will create the mine pool level control lake. Figure 26 has been developed for preliminary design and cost estimating purposes only. The typical dam section used in cost estimates was derived from the Bureau of Reclamations manual "Design of Small Dams." Detailed design and an onsite evaluation must be conducted during the engineering phases for construction. The estimates obtained using the preliminary design criteria, however, are considered to provide a valid cost analysis for the proposed project.

In the flooding of the Banner Mine area, the possibility of a structural leak exists at the Ashby-Pendergast mine (Figure 25). It is possible that the Banner Mine may have cut into the Pendergast Mine, but this is conjecture. Bulkhead seals will be required at the Ashby-Pendergast Mine to withstand about 29 m (95 ft) of head. A proposed design for a movable wall bulkhead seal is included as Appendix D.

A dewatering borehole exists on Snowy Creek in Maryland at 4,362,229 m north and 630,847 m east (Universal Transverse Mercator Projection). The


CONTINUOUS CLAY DAMS WITH DIVERSION DITCHES
AND SETTLING PONDS. FOR DETAILS SEE FIGURES
[illegible]
PLUG BOREHOLE
STRUCTURE CONTOUR 2460
TOPOGRAPHIC CONTOUR 2460
SHORE LINE OF PROPOSED LAKE
FREEPORT STRIP MINE
WEST VIRGINIA
MARYLAND

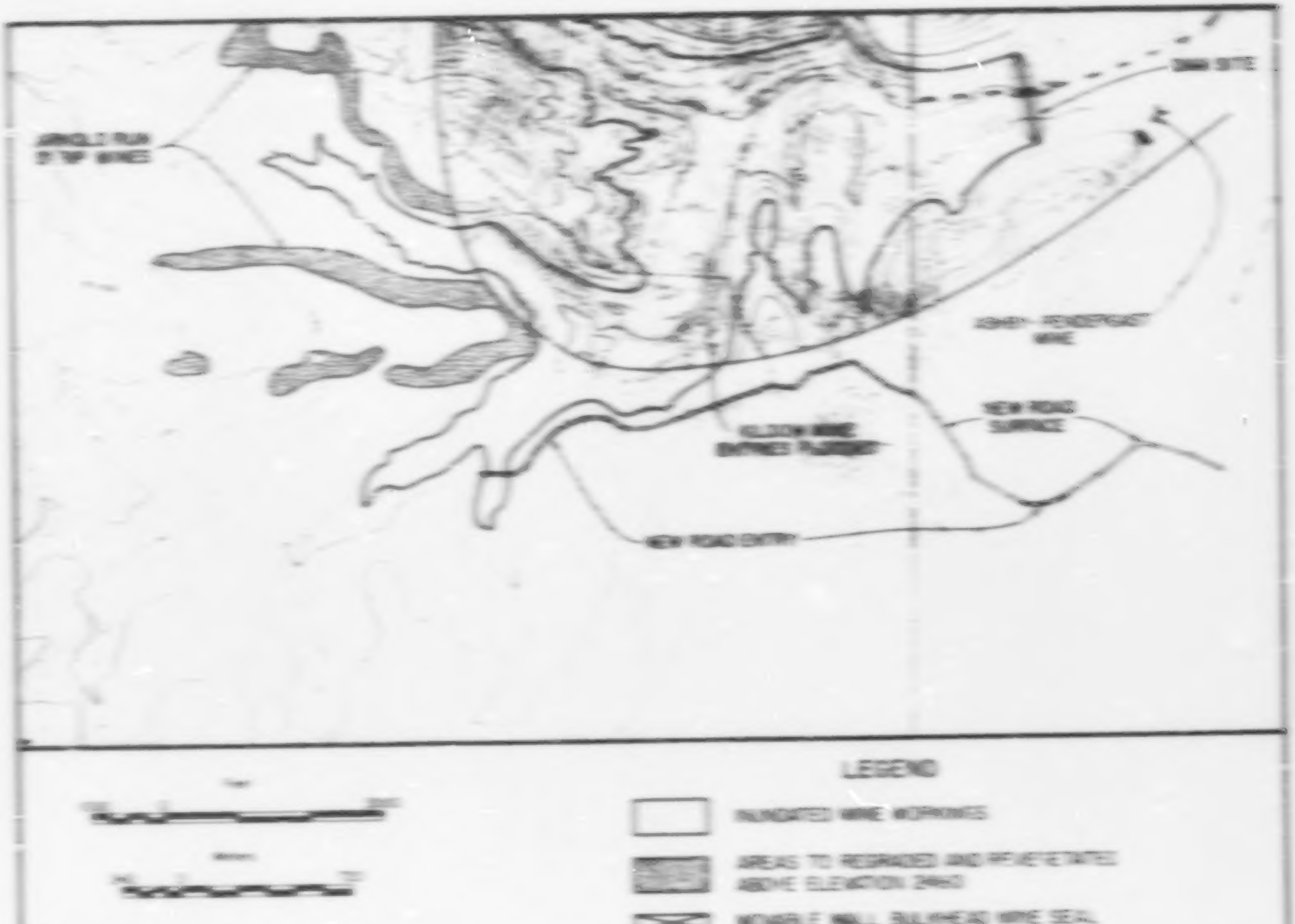
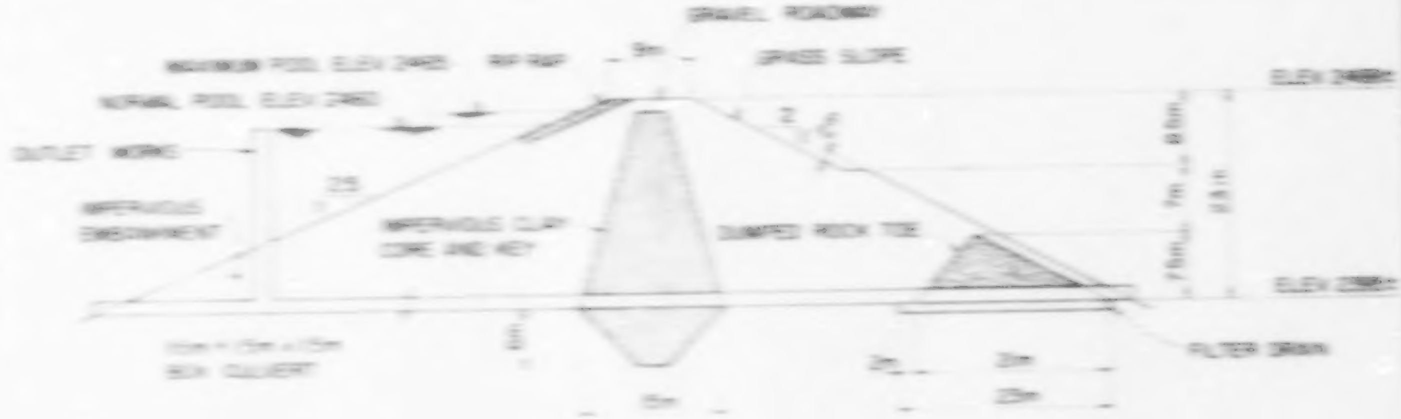

ARNOLD RUN STRIP MINES
DAM SITE
ASHBY - PENDERGRAST MINE
NEW ROAD SURFACE
KILDOW MINE ENTRIES PLUGGED
NEW ROAD ENTRY
LEGEND
INUNDATED MINE WORKINGS
AREAS TO REGRADED AND REVEGETATED ABOVE ELEVATION 2440
MOVABLE WALL BULKHEAD MINE SEAL
Feet
Meters

Figure 25. Bremer Mine abatement plan.


GRAVEL ROADWAY
MAXIMUM POOL ELEV 2485
RIP RAP
5m
GRASS SLOPE
NORMAL POOL ELEV 2480
OUTLET WORKS
2.5
1
IMPERVIOUS EMBANKMENT
IMPERVIOUS CLAY CORE AND KEY
DUMPED ROCK TOE
2
1
7.5m
7m
8.5m
23 m
FILTER DRAIN
BOX CULVERT
2m
21m
23m
15m

(NO SCALE)

Figure 26. Earth dam section used for quantity and cost estimates.

borehole is presently not discharging water and is plugged with caved material. However the surface elevation is 733 m (2,405 ft) which is below the elevation of the proposed control lake. This hole must be sealed with a concrete plug before raising the Banner Mine pool.

The remaining areas requiring abatement as considered by the proposed design would include only those locations situated above the level of the control lake, such as the Arnold Run strip mine area and the Freeport mined area. It is important to note here that the impoundment created by the proposed earth dam should inundate the Kildow Mine entries at an elevation of 747 m (2,452 ft).

Abatement in the Arnold Run area would include a standard regrading, construction of diversion ditching, and revegetation done primarily to limit the amount of water introduced to the old spoil area. The Freeport area is also a regrading and revegetation scheme aimed primarily at improving the appearance of the area that lies immediately adjacent to the proposed control lake.

Alternative Design--

As previously mentioned, the conventional approach of rechanneling and lining Laurel Run, sealing boreholes, curtain grouting subsidence areas, removing and burying mine waste, regrading and revegetation might also be used to abate acid mine drainage in the Banner Mine area. But this approach was rejected because of the complex conditions that render the abatement possibilities very questionable.

The alternative design considered an individual abatement method for each problem area and includes subsidence area grouting in the Turner Douglass area, borehole sealing, rechanneling and lining Laurel Run over the Banner Mine, removing and burying of the mine waste at Turner Douglass, and regrading and revegetation in the Turner Douglass, Freeport, and Arnold Run areas.

The alternative design addressed each problem area from the standpoint of increasing the abatement percentage for the Laurel Run area as a whole. An extensive curtain grouting program would be needed to seal the main Banner Mine in the area immediately adjicent to the subsidence-formed swampy area. But such a program would require some knowledge of the number of blind seals needed to guarantee effective inundation of workings. Abatement estimates using this approach are extremely questionable.

The alternative design also proved to be the most costly abatement approach. A complete summary of cost is presented in the following section on capital and operating cost.

Conclusions--

Because the percentage of abatement would be relatively certain, the design approach is the recommended abatement method. The project basin will exhibit a better quality of discharge utilizing the recommended design, and the aesthetic appearance of the project area will be enhanced.

The recommended design is also the least expensive, based on the preliminary cost analysis, presented in the following section.

CAPITAL AND OPERATING COSTS

The following presents estimated abatement costs for the Lima and Banner Mine abatement plans. In presenting the Banner Mine cost estimates, a detailed analysis of the proposed design and the alternative design are included.

Lima Mine Abatement Cost

The cost analysis presented (Table 7) is based on the type of construction and equipment found available in an active surface mining operation. The largest single cost item in the abatement work proposed for the Lima Mine is the excavation of approximately 419,648 m^3 (548,900 yd^3) of overburden. This large amount of earthwork is required to install the continuous clay core dam.

Items such as diversion ditching, settling ponds, lime application, and swale ditching are included to handle runoff during the construction phases of the abatement work. All construction will conform to existing State and Federal guidelines pertaining to this type of work.

In excavating the overburden to install the continuous clay core dam, a sizable amount of marketable coal is likely to be recovered. Proceeds from its sale could be used to reduce the total project cost.

Recovery figures presented here are based on at least 25 percent of the coal remaining on the Corinth side and 20 percent of the coal remaining on the Freeport side. The percentages used as recovery figures are based on the existence of past underground mining activity. Therefore actual coal recovered may vary according to the extent of underground mining. The recovery of coal could lower the project cost by greater than 40 percent.

Banner Mine Abatement Cost

Cost estimates have been developed for both the design and the alternative abatement plans at the Banner Mine area.

The Design--

Abatement costs covered by the proposed design (Table 8) addresses needs in four main areas. The main Banner Mine complex is handled by the proposed earth dam creating the mine pool level control lake. The closing of the Kildow Mines will also be completed by the impoundment inundating to an elevation of 750 m (2,460 ft). The remaining areas above the impoundment, the Arnold Run strip area and the Freeport area, are covered by a limited program of regrading and revegetation.

TABLE 7 LIMA MINE ABATEMENT COST ESTIMATES

Item	Amount
Drilling, 30,980 m @ $2.34/m	$ 72,500.00
Blasting, 30,980 m @ $1.27/m	39,300.00
Excavation, 419,648 m^3 @ $.72/$m^3$	302,100.00
Diversion ditching, 1,218 m @ $3.61/m	4,400.00
Settling ponds, 64 dozer hr. @ $57.75/hr.	3,700.00
Swale ditching, 1,082 m @ $3.61/m	3,900.00
Lime application, lump sum	2,200.00
Move and install	
Impervious clay, 20,325 m^3 @ $1.80/m	36,600.00
Backfill to contour, 4.7 ha @ $4,620.00/ha	21,700.00
Revegetation, 4.7 ha @ $1,360.00/ha	6,400.00
Construction cost	$ 492,800.00
Construction contingency @ 10% of construction cost	49,300.00
Total construction cost	$ 542,100.00
Engineering cost @ 7.9% of total construction cost	42,800.00
Administrative and legal contingency @ 5% of total construction cost	27,100.00
Project cost	$ 612,000.00
Project contingency @ 5% of project cost	30,600.00
Total project cost (Lima Mine)	642,600.00
Potential credit for coal marketed during construction, 10,770 metric tons @ $23.15/ton	249,300.00
Net project cost (Lima Mine)	$ 393,300.00

TABLE 8 BANNER MINE ABATEMENT COST ESTIMATES: DAM AND IMPOUNDMENT

Item	Amount
Pervious material, 282,137 m^3 @ $2.75/$m^3$	$ 775,900.00
Impervious clay core, hauled in	249,100.00
Rip rap, 3,755 m^3 @ $24.72/$m^3$	92,800.00
Dumped rock toe, 13,381 m^3 @ $8.93/$m^3$	119,500.00
Filter drain, 4,650 m^3 @ $16.49/$m^3$	76,700.00
Class A concrete, 1,008 m^3 @ $343.75/$m^3$	346,500.00
Class B concrete, for items such as a spillway, 994 m^3 @ $274.65/$m^3$	273,000.00
Topsoil, seeding, 10,869 m^2 @ $2.51/$m^2$	27,300.00
Storage shed and parking area, lump sum	42,000.00

(Continued)

TABLE 8 (continued)

Item	Amount
Outlet tower, lump sum	17,900.00
Slide gate, stem and mountings, lump sum	21,000.00
Clearing and grubbing, lump sum	65,900.00
Movable wall mine seals, 2 @ $21,000.00/seal	42,000.00
Borehole grouting, lump sum	5,300.00
Subtotal	$ 2,154,900.00
New access road:	
Excavation, 45,830 m^3 @ $4.12/$m^3$	188,800.00
Surfacing (gravel road), 4.8 km @ $34,440.00/km	165,300.00
Drainage, 171 m @ $137.60/m	23,500.00
Clearing and grubbing, lump sum	5,300.00
Seeding and mulching, lump sum	10,500.00
Subtotal	$ 393,400.00
Land acquisition:	
Land for roadway and impoundment, 270 ha @ $418.00/ha	112,900.00
Improvements, lump sum	68,300.00
Subtotal	$ 181,200.00
Arnold Run strip area (east and west bank):	
Regrading, 39.8 ha @ $4,400.00/ha	175,100.00
Revegetation, 39.8 ha @ $1,360.00/ha	54,100.00
Diversion ditching, 4602 m @ $3.61/m	16,600.00
Subtotal	$ 242,600.00
Freeport area:	
Regrading, 5.9 ha @ $4,400.00/ha	26,000.00
Revegetation, 5.9 ha @ $1,360.00/ha	8,000.00
Subtotal	$ 34,000.00
Construction cost	$ 3,006,100.00
Construction contingency @ 10% of construction cost	300,600.00
Total construction cost	$ 3,306,700.00
Engineering cost @ 5.5% of total construction cost	181,900.00
Administrative and legal contingency @ 5% of total construction cost	165,300.00
Project cost	$ 3,653,900.00
Project contingency @ 5% of project cost	182,700.00
Total project cost (Banner Mine)	$ 3,836,600.00
Total project cost (Lima Mine)	642,600.00
Total abatement cost (proposed design)	$ 4,479,200.00
Potential credit for coal marketed during construction	249,300.00
Net abatement cost (proposed design)	$ 4,229,900.00

The Alternative--

Areas requiring abatement were the same as outlined in the design, however, a different method of abatement at the Banner Mine complex was used. Estimated costs for the alternative design are shown in Table 9.

TABLE 9. ESTIMATED COSTS FOR THE ALTERNATIVE BANNER MINE DESIGN

Item	Amount
Channel relocations, 3,292 m @ $69.30/m	$ 228,100.00
Mine waste burial, 1,006,836 m^3 @ $1.24/m^3	1,248,500.00
Regrading, 30.4 ha @ $4,400.00/ha	133,800.00
Revegetation, 30.4 ha @ $1,360.00/ha	41,300.00
Blind seals (for subsidence area), 200 seals @ $10,500.00/seal	2,100,000.00
Movable wall mine seals (Kildow Mine + Ashby-Pendergast Mines), 4 seals @ $21,000.00/seal	84,000.00
Subtotal	$ 3,835,700.00
Arnold Run Strip Area (east and west bank):	
Regrading, 39.8 ha @ $4,400.00/ha	$ 175,100.00
Revegetation, 39.8 ha @ $1,360.00/ha	54,100.00
Diversion ditching, 4,602 m @ $3.61/m	16,600.00
Subtotal	$ 242,600.00
Freeport area:	
Regrading, 5.9 ha @ $4,400.00/ha	$ 26,000.00
Revegetation, 5.9 ha @ $1,360.00/ha	8,000.00
Subtotal	$ 34,000.00
Construction cost	$ 4,112,300.00
Construction contingency @ 10% of construction cost	411,200.00
Total construction cost	$ 4,523,500.00
Engineering cost @ 5.3% of total construction cost	239,700.00
Administrative and legal contingency @ 5% of total construction cost	226,200.00
Project cost	$ 4,989,400.00
Project contingency @ 5% of project cost	249,500.00
Total project cost (Banner Mine)	$ 5,238,900.00
Total project cost (Lima Mine)	642,600.00
Total abatement cost (alternative design)	$ 5,881,500.00
Potential credit for coal marketed during construction	249,300.00
Net abatement cost (alternative design)	$ 5,632,200.00

SECTION 7

IMPLEMENTATION AND OPERATING PLANS

Neither West Virginia nor Maryland alone can implement a feasible successful abatement demonstration project for the Snowy Creek - Laurel Run watershed. Such a project requires either interstate or State-Federal cooperation, or solely Federal involvement.

Since a cooperation effort in needed for the success of the total demonstration project a "lead" agency should be designated as rapidly as possible to evaluate the general involvement of the various government agencies. Screening must be limited to general project scope relative to agency programs. Once the joint venture of government agencies has been assembled, the detailed negotiations between agency programs can be resolved as the other phases of the demonstration project work are being implemented.

Figure 27 presents a timetable of activities that delineates the time periods necessary to accomplish major tasks relative to the proposed abatement demonstration project. This schedule indicates that more than 2 years will be required to perform the design and construction phases of the proposed projects. One year will be required in order to fill and stabilize the proposed lake. In addition, a minimum of 1 hydrological year of monitoring following completion of construction will be required to evaluate the impact of the demonstration project on the water quality of the Youghiogheny River Basin.

Development of engineering plans for construction of the proposed demonstration projects will be in accordance with accepted procedures of the mining industry. Similarly, the U.S. Department of Agriculture, Soil Conservation Service criteria and design considerations will be followed for the development of the engineering plans for the earth structure for the proposed impoundment at the Banner Mine site.

The primary purpose of the proposed demonstration project is to reduce the abandoned mine drainage pollution load being discharged to the Snowy Creek - Laurel Run watershed. Therefore, annual operation of the demonstration project would consist of downstream monitoring of water quality and maintenance of the physical facilities. The proposed Lime Mine abatement is a fixed condition not subject to manipulation. The proposed Banner Mine abatement could be manipulated, but its success is contingent to a major extent on maintaining a nearly constant, static impoundment. Thus operation plans are reduced to routine monitoring and maintenance of physical facilities.

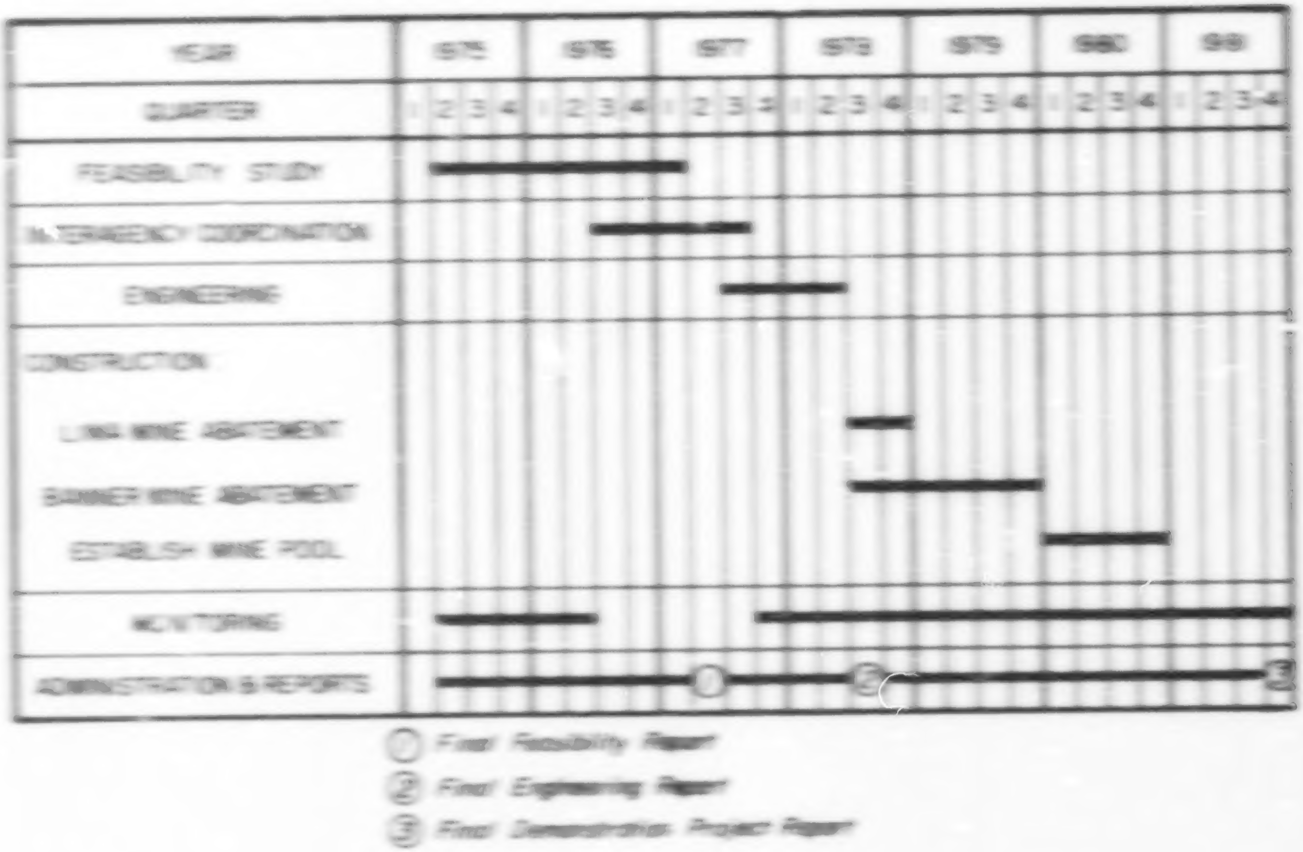


Figure 27. Snowy Creek–Laurel Run project implementation schedule.

SECTION 8

EFFECTIVENESS OF PROJECT

DEMONSTRATION VALUE

The true value of the proposed abatement depends on the effectiveness of the impoundment structures in inundating deep mine workings. In the Lima Mine project, a continuous clay core dam will be used to create an increased mine pool size with a controlled level. This packing may be envisioned as a subsurface trench dam. At the Banner Mine, an earth dam will create an impoundment. The level of the control lake will raise the mine pool and inundate large portions of the Banner Mine workings.

Surface water is now entering the Banner Mine through extensively broken strata in the valleys, especially that of Little Laurel Run. This water now mixes with the waters of the mine pool, circulates through the workings at depth and reports to the surface at the two primary discharge points (Station 11 and F). Establishing the level of the control lake above most points where surface water enters the existing mine pool will eliminate the hydraulic pressure differential responsible for water movement within the mine workings and for the artesian flows at points of discharge. Unpolluted water charging the proposed lake should not become contaminated. Parenthetically, the pH in the underground mine pool will also improve significantly with the stoppage of circulation.[12] In addition, the control lake will inundate mine waste in the vicinity of Turner-Douglass. This action will prevent subaerial acid mine drainage production from the piled and scattered mine waste at the surface.

It is felt that the Banner Mine abatement procedure will provide an effective new approach for eliminating major pollution from favorably situated abandoned mines that have significant fractured overburden and/or surface subsidence.

Implementation of the proposed abatement project at the Lima Mine would reduce acid loadings in Snowy Creek by 1,487 kg/day (3,279 lb/day) for a reduction of about 70 percent. At 80 percent effectiveness of the proposed abatement, the total cost of $642,600 indicates that each kilogram of acid abated cost $432 ($196/lb). This reduction of acid loading would clean up approximately 6.2 km (3.83 miles) of Snowy Creek.

Construction of the proposed design to abate pollution at the Banner Mine should reduce acid loadings from 2,169 kg/day (4,782 lb/day) to 217 kg/day (478 lb/day). Based on an abatement effectiveness of 90 percent, the total project cost of $3,836,600 would amount to $1,967/kg ($891/lb) of acid removed. Laurel Run would then have 1.6 km (0.98 miles) of cleaner discharge. More important, a new lake would be created with 250 ha (618 acres) of surface area and 17.4 km (10.8 miles) of shoreline. Aesthetic improvement to the entire area both in terms of natural beauty and sanctuary for fish and wildlife will be a definite bonus of the abatement project.

It has been recognized that when impoundments are properly designed and constructed in areas of abandoned mining the resulting ponds can be suitable for supporting and propogating aquatic life.[11] The water quality of the proposed lake should approach values for surface water in the vicinity. It is estimated that the pH will range between 4.6 and 5.4, acidity will be approximately 10-16 mg/l and specific conductivity will range from 50-60 micromhos. These values are similar to values of unpolluted waters as measured at Stations 15 and 16 (Appendix C).

Waters of the above composition will support panfish and other warm water fish. The natural waters of the Laurel Run watershed should not be expected to support fish intolerant to low pH water. Repeated attempts to maintain trout in the natural waters of Laurel Run as found in the pond at Grimm Lumber Company (Sample Station 6) have failed. However, bass, sunfish and panfish have flourished.

During construction of the demonstration project, a monitoring program should be implemented during and after abatement to assess effectiveness of the project. Together, both segments of the total Snowy Creek project would cost an average of $1,200 for each kilogram ($544/lb) of acid removed.

PUBLIC BENEFITS

The proposed abatement project could eliminate 3,437 kg/day (7,583 lb/day) of acid which is dumped into Snowy Creek - Laurel Run by abandoned mines. This reduction of acid loads to the Snowy Creek - Laurel Run Basin will clean up 6.3 km (3.9 miles) of stream in Maryland and 1.5 km (0.91 miles) of stream in West Virginia. The abatement project will also create a lake, having 17.4 km (10.8 miles) of shoreline and 250 ha (618 acres) of surface area, which will be situated in both Maryland and West Virginia.

With the elimination of 3,437 kg/day (7,583 lb/day) of acid in the study basin, the loads on the Youghiogheny River will also be reduced by an equal amount. The reduced acid loads would now clean up the 7 km (4.4 miles) on the Youghiogheny River, (beginning at its confluence with Snowy Creek and ending at its confluence with the Little Youghiogheny River) recognized by Maryland's Water Resources Administration as severly affected by acid mine drainage from Snowy Creek. Reduced acid loadings would also be carried further downstream on the Youghiogheny River.

Although the lake is primarily a pollution control device, the resulting body of water will definitely have a positive effect in attracting new recreational facilities and providing improved fish and wildlife habitats.

The proposed abatement project could fit into the plan of making the Youghiogheny River a National Wild River. The new segment on Snowy Creek and Laurel Run would become another area deserving future preservation under the program.

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APPENDIX A
MINE PRODUCTION RECORDS*

TABLE 1-A. MINE PRODUCTION, CORINTH - LIMA MINE AREA

Year	Mine	Owner	Production (tons)
1898	Corinth	Oakland Coal + Coke Company	6,330
1899	Corinth	"	8,653
1900	Corinth	"	24,000
1901	1901-1902	"	No record
1903	Corinth	"	29,950
1904	Corinth	"	46,276
1905	Corinth	"	29,079
1906	Corinth	"	31,919
1907		"	No record
1908	Corinth	"	20,200
1909	Corinth	"	9,000
1910	Corinth	Jorden Coal Co.	25,780
1911	Corinth	"	18,210
1912	Corinth	"	20,099
1913 1921	1913-1921	"	No production recorded
1922	Lima #1	Lindsey Coal Mining Company	12,600
1923	Lima #1	"	29,956
1924	Lima #1	"	3,689
1925	Lima #1	"	4,052
1926	Lima #1	"	13,419
1927	Lima #1	"	53,560
1928	Lima #1	"	62,469
1929	Lima #1	"	39,215
1930	Lima #1	"	11,215
1931	Lima #1	"	2,600
1932 1961	1932-1961		No production recorded
1962	Princess Pat	Princess Pat Coal Company	1,623
1963	Princess Pat	"	9,603
1964	Princess Pat	"	7,765
1965	Princess Pat	"	3,746
1966	Princess Pat	"	5,959
1967 1952	1967-1952		No production recorded

(continued)

Table 1-A. (continued)

Year	Mine	Owner	Production (tons)
1953	L+L #1	L+L Coal Co. + Merging Coal Co.	4,894
1954	L+L #1	"	3,826
1955	L+L #1	"	14,883
1956	L+L #1	"	61,164
1957	L+L #1	"	67,061
1958	L+L #1	"	17,910
1959	L+L #1	"	1,517
1960	L+L #1	"	885
1961 1974	1961-1974		No mining
1975	15-75	Grafton Coal Co.	88,829
Total production	---	---	791,930

* Source: West Virginia Department of Mines.

TABLE 2-A. MINE PRODUCTION TURNER DOUGLASS - BANNER MINE AREA

Year	Mine	Owner	Production (tons)
1913	Arnold #1	Kendall Lumber Co.	10,714
1914	"	"	9,030
1915	"	"	10,564
1916	"	"	4,000
1917	"	"	5,400
1918	Arnold #1, #2 + Guthrie	"	37,310
1919	"	"	48,397
1920	"	"	46,335
1921	"	"	45,316
1922	"	"	23,119
1923	"	"	33,353
1924	"	"	990
1925	Arnold #2	"	10,407
1926	"	"	15,154
1927	"	"	10,501
Total	---	---	310,590
1920	Kildow	Kildow Coal Co.	21,728
1921	"	"	12,039
1922	"	"	8,110
1923	"	"	13,790
Total	---	---	55,667

TABLE 3-A. MINE PRODUCTION FREEPORT - LAUREL RUN AREA

Year	Mine	Owner	Production (tons)
1919	Crane	Freeport Coal Co.	6,000
1920	"	"	51,691
1921	Crane * Kerns	"	40,802
1922	"	"	30,633
1923	Thayer #1, + #2	"	55,910
1924	"	"	8,805
1925	"	"	17,819
1926	Thayer #1	"	36,512
1927	"	"	23,256
1928	"	Laurel Valley Coal Company	6,729
1929	"	"	41,121
1930	"	"	56,208
1931	"	"	40,111
1932	"	"	23,318
1933	"	"	22,107
1934	"	"	43,187
1935	"	"	21,580
Total	---	---	525,789
1921	Laurel Mine	Laurel Run Coal Company	14,414
1922	"	"	0
1923	"	"	6,702
1924	Fern + Laurel	Fern Coal Co.	5,755
1925	"	"	13,469
1926	"	"	13,264
1927	"	"	979
Total	---	---	54,583
1921	Freeport	MDW Coal Co.	10,586
1922	"	"	750
1923	"	"	9,000
Total	---	---	20,336
1953	Old Ben	Murdock Coal Co.	6,577
1954	"	"	5,455
1955	"	"	5,207
1956	"	"	2,856
Total	---	---	20,095

TABLE 4-A. MINE PRODUCTION, BANNER MINE

Year	Owner	Comments	Production (tons)
1919	Turner Douglass Coal Company	---	8,714
1920	"	---	21,281
1921	"	---	0
1922	Oakland Coal Co.	---	15,622
1923	Stanley Coal Co.	---	49,176
1924	"	Introduced mining machines	63,919
1925	"		145,669
1926	"		177,210
1927	"	95% Mining machines	207,993
1928	"	1927-1931 rank	207,707
1929	"	3rd in production	217,164
1930	"	in Preston County	197,761
1931	"	100% mining machines	126,299
1932	"		105,198
1933	"	1932-1940 ranked	116,203
1934	"	1st in production	170,611
1935	"	in Preston County	172,838
1936	"		163,708
1937	"		120,578
1938	"	1938 produced 41% of	144,197
1939	"	Preston County total	221,667
1940	"		209,637
1941	"	1941 ranked 2nd in	124,100
1942	"	production in Preston County	164,357
1943	"		123,227
1944	"		90,916
1945	"		83,193
1946	"		85,622
1947	"		91,295
1948	"		95,265
1949	"		161,199
1950	"	Begin final decline	92,010
1951	"		12,082
1952	"		11,231
1953	"		51,681
1954	"		26,413
1955	"		63,367
1956	"	Last year of production	20,970
Total	---	---	4,228,775

TABLE 5-A. MINE PRODUCTION PRESTON COUNTY

Year	Tons	Year	Tons
1890	159,664	1936	634,467
1894	39,936	1937	595,005
1897	120,211	1938	353,412
1898	169,044	1939	588,701
1899	277,173	1940	784,389
1900	403,610	1941	1,444,752
1901	No Record	1942	1,355,898
1902	No Record	1943	1,808,594
1903	574,741	1944	1,858,175
1904	689,139	1945	1,863,163
1905	651,122	1946	2,476,625
1906	827,772	1947	2,614,357
1907	No Record	1948	2,512,016
1908	874,786	1949	2,388,443
1909	654,333	1950	2,142,305
1910	1,033,902	1951	1,538,846
1911	888,202	1952	1,213,433
1912	841,801	1953	1,228,513
1913	999,161	1954	1,068,263
1914	1,281,181	1955	2,224,145
1915	980,322	1956	1,468,742
1916	1,266,189	1957	2,193,702
1917	1,106,378	1958	1,814,361
1918	1,400,961	1959	2,062,663
1919	1,325,451	1960	2,882,567
1920	1,704,574	1961	2,640,876
1921	1,439,506	1962	2,960,702
1922	939,769	1963	3,080,065
1923	2,182,164	1964	3,240,422
1924	1,668,552	1965	3,922,023
1925	2,733,880	1966	2,188,234
1926	2,165,139	1967	2,717,493
1927	1,970,942	1968	2,239,403
1928	1,921,422	1969	2,415,362
1929	1,934,441	1970	2,470,130
1930	1,600,755	1971	1,906,580
1931	972,289	1972	1,641,960
1932	613,973	1973	1,666,572
1933	597,892	1974	2,822,038
1934	74[illegible],699	1975	
1935	736,479		
Total	xxx	xxx	117,509,277

APPENDIX B
METRIC COORDINATES

METRIC COORDINATES

Sample No.	Identification	Universal transverse mercator zone 17 coordinates (m)		Type of sample station	Control
		North	East		
0001	Lima Mine	4,363,941	629,254	Weekly sample	Double 8" V-notch weir
0002	Lima Mine	4,363,929	629,214	Grab sample	—
0003	Snowy Creek (Above Corinth)	4,365,664	629,032	Bi-weekly sample	Stage discharge curve
0004	Snowy Creek (bridge)	4,364,240	629,585	Grab sample (Monthly)	—
0005	Snowy Creek	4,363,609	630,794	Bi-weekly sample	Stage discharge curve
0006	Md.-W. Va. State Line	4,362,929	630,147	Grab sample (Bi-weekly)	—
0007	Swamp Discharge (Bridge)	4,362,902	629,736	Grab sample	36" CMP
0008	Md.-W. Va. State Line	4,362,216	630,756	Grab sample (Bi-weekly)	—
0009	Snowy Creek (Crellin)	4,360,575	631,707	Bi-weekly	Stage discharge curve

(continued)

Metric coordinates (continued)

Sample No.	Identification	universal transverse mercator zone 17 coordinates (m) North	East	Type of sample station	Control
0010	Snowy Creek (Crellin) Below Laurel Run	4,360,812	632,156	Weekly	Stage discharge curve
0011	Slime Hole	4,360,410	630,726	Weekly	Double 8" V-notch weir
0012	Laurel Run	4,360,144	629,887	Bi-weekly	Stage discharge curve
0013	Kildow Mine	4,359,240	629,808	Bi-weekly	8" V-notch weir
0014	Kildow Mine	4,359,228	629,759	Bi-weekly	8" V-notch weir
0015	Laurel Run	4,359,132	629,056	Bi-weekly	Stage discharge curve
0016	Arnold Run	4,359,412	629,266	Bi-weekly	Stage discharge curve
0017	Little Laurel Run South of Freeport	4,360,914	628,708	Bi-weekly	Stage discharge curve
0018	Little Laurel Run (Road)	4,361,362	628,358	Grab sample	48" Concrete pipe
0050	Out of GOB (Near 0009)	4,359,635	629,732	Grab sample	—
0051	Grab	4,361,240	628,024	Grab sample	—
0052	Grab	4,360,448	632,250	Grab sample	—

(continued)

Metric coordinates (continued)

Sample No.	Identification	Universal transverse mercator zone 17 coordinates (m) North	East	Type of sample station	Control
0054	Grab	4,363,549	629,336	Grab sample	—
0100	Beckhart Hole	4,360,012	630,408	Grab sample	—
0101	Beckhart Stream	4,359,448	630,360	Grab sample	—
0102	Stream at 0013 and 0014	4,359,225	629,770	Grab sample	8" V-notch weir
0103		4,364,525	628,981	Grab sample	—
0104	Pond Drainage	4,364,279	629,011	Grab sample	—
0105		4,364,137	629,037	Grab sample (Bi-weekly)	
0106	Grafton Strip Drain	4,364,272	629,136	Grab sample (Bi-weekly)	12" Pipe
0107	Mine Pit Drain into 0009A	4,364,663	629,465	Grab sample	
0108-F	Swamp Drain into 0012	4,360,171	629,862	Grab sample	—
0109	Pond above Grafton	4,364,387	628,817	Grab sample	—
0110	Simms Mine	4,358,760	630,050	Grab sample	—

(continued)

Metric coordinates (continued)

Sample No.	Identification	Universal transverse mercator zone 17 coordinates (m) North	East	Type of sample station	Control
[illegible]	Stream (Corinth)	4,364,619	629,397	Grab sample (Bi-weekly)	—
[illegible]	Swamp Drain into [illegible]	4,364,648	629,390	Grab sample	—
[illegible]	Gralton Settling Pond	4,364,291	629,148	Grab sample	—
[illegible]	Stream at Corinth	4,364,800	630,125	Grab sample (Bi-weekly)	36" Concrete pipe
[illegible]	Stream into Laurel Run	4,360,372	631,260	Grab sample (Bi-weekly)	—
[illegible]	Yellow Bay [illegible]	4,360,048	629,667	Grab sample	8" V-notch weir
[illegible]	Glory Hole	4,359,643	629,728	Weekly	Double 8" V-notch weir
[illegible]	Grimes Pond Outfall	4,358,724	628,792	Grab sample	—
[illegible]	Headwater Laurel Run at Bridge	4,354,460	627,108	Monthly	Stage discharge curve
[illegible]	Spring	4,360,341	629,626	Grab sample	—
[illegible]	[illegible] Flow	4,359,550	629,503	Grab sample	—

(continued)

Metric coordinates (continued)

Sample No.	Identification	Universal transverse mercator zone 17 coordinates (m) North	 East	Type of sample station	Control
000K	Valley Ditch (Freeport)	4,361,635	628,365	Grab sample (Monthly)	—
000L	Pond at [illegible]	4,360,175	631,602	Grab sample	8" V-notch weir
000M	Arnold Mine	4,359,662	628,240	Bi-weekly	8" V-notch weir
[illegible]	Prendergast	4,360,156	631,592	Monthly	8" V-notch weir
000P	Arnold Run Headwater	4,360,673	628,767	Grab sample (Monthly)	—
[illegible]	Arnold Strip	4,359,650	627,988	Bi-weekly	8" V-notch weir
[illegible]	Strip Outbreak	4,359,738	628,024	Grab sample	—
[illegible]	Strip Outbreak	4,359,549	628,388	Grab sample	—
[illegible]	Strip Mine	4,359,400	628,912	Bi-weekly	8" V-notch weir
[illegible]	Highwall at Grimms	4,359,472	628,506	Grab sample	—
[illegible]	Stream at Turner Douglass	4,359,234	629,650	Grab sample	—
[illegible]	Road to Alpine Lake	4,367,691	628,300	Grab sample (Monthly)	2 - 48" x 76" Concrete pipes
[illegible]	Pritt Farm	4,363,336	628,758	Grab sample	—

(continued)

Metric coordinates (continued)

Sample No.	Identification	Universal transverse mercator zone 17 coordinates (m)		Type of sample station	Control
		North	East		
00EE	Stream to Lima	4,366,051	626,920	Grab sample	—
00FF		4,365,014	627,290	Grab sample	—
00GG	Cora Drill	4,360,964	629,676	Grab sample	—
00II	Arnold Strip	4,359,621	628,000	Bi-weekly	8" V-notch weir
TB01	Tough Below Snowy Creek	4,361,094	632,345	Grab sample	—
TB02	Tough Below Snowy Creek	4,358,096	632,465	Grab sample	—
	Bridge at Meadtor	4,360,677	632,312	No sample	—

APPENDIX C

COMPUTERIZED PRINTOUT* - COMPREHENSIVE WATER ANALYSES

Presented is a detailed summary of all samples collected during the course of the study. The tables presented are from standard IBM computer sheets that have been reduced photographically in order to be included in the report. Comprehensive water analyses are also included in this section.

The chemical analyses of the Snowy Creek and Laurel Run samples for aluminum, calcium, chromium, copper, iron, lead, magnesium, manganese, potassium, sodium and zinc were completed by atomic absorption spectrophotometry. The analyses for ferrous iron, sulfate, hexavalent chromium and fluoride were performed colorimetrically using the reference, "Standard Methods for the Examination of Water and Wastewater," 13th Edition 1971 APHA, AWWA, WPCF. Acidity, total solids, suspended solids, and chemical oxygen demand were determined in accordance with the methods expressed in "Methods for Chemical Analysis of Water and Wastes," 1974, EPA. pH was measured electrometrically. Specific conductance was determined at 25° C by using a Wheatstone bridge. Chloride was analyzed by using the mercuric nitrate titration method found in "Annual Book of Standards, Part 23, Water, Atmospheric Analysis," 1972, ASTM. Turbidity was determined in a turbidimeter and all hardness values reported were calculated in accordance with Standard Methods using the atomic absorption values obtained for Ca, Mg, Fe, Al, Zn, and Mn.

* Headings on computer sheets labeled "IRON (FERR)" refer to ferrous iron.

TABLE 1-C. SAMPLE STATION 0001, LIMA MINE

Analysis a	May 15, 1975	December 6, 1975	May 3, 1976
pH	2.60	2.50	2.96
Acidity	450.00	650.00	464.00
Alkalinity	0.00	0.00	0.00
Iron (total)	62.00	72.00	66.00
Iron (ferrous)	0.50	8.00	11.00
Specific conductance (uMhos)	1,350.00	1,350.00	960.00
Sulfate (as SO_4)	550.00	675.00	580.00
Aluminum	44.00	50.00	43.00
Cadmium	--	0.002	0.007
Calcium	22.00	26.00	28.00
Chromium (hexavalent)	0.01	0.01	0.01
Chromium (total)	0.01	0.01	0.01
Copper	0.09	0.04	0.10
Cyanide	--	0.01	0.06
Lead	0.05	0.05	0.05
Magnesium	9.30	11.50	11.50
Manganese	0.68	0.80	1.30
Mercury	--	ND	0.001
Potassium	1.10	1.30	1.20
Sodium	0.42	0.50	0.47
Zinc	0.69	0.82	0.81
Arsenic	--	0.011	0.002
Turbidity (APHA units)	0.44	1.30	1.50
Total solids	1,000.09	980.00	916.00
Suspended solids	0.20	0.80	14.50
Total organic carbon	--	0.65	5.90
Chloride	4.00	5.00	5.00
Fluoride	0.65	0.70	0.72
C.O.D.	8.60	6.50	17.00
Hardness	450.00	522.00	479.00

Units expressed in mg/l unless noted otherwise.

TABLE 2-C. SAMPLE STATION 0011, SLIME HOLE

Analysis	May 15, 1975	December 8, 1975	May 3, 1976
Ph	3.00	2.90	2.90
Acidity	135.00	430.00	368.00
Alkalinity	0.00	0.00	0.00
Iron (total)	93.00	120.00	100.00
Iron (ferrous)	90.00	120.00	96.00
Specific conductance (uMhos)	1,060.00	1,180.00	1,080.00
Sulfate (as SO_4)	595.00	635.00	570.00
Aluminum	29.00	27.00	28.00
Cadmium	--	0.002	0.008
Calcium	55.00	53.00	50.00
Chromium (hexavalent)	0.01	0.01	0.01
Chromium (total)	0.01	0.01	0.01
Copper	0.06	0.03	0.08
Cyanide	--	0.01	0.07
Lead	0.05	0.05	0.05
Magnesium	20.00	21.00	24.00
Manganese	2.00	2.10	1.70
Mercury	--	ND	0.001
Potassium	3.50	2.90	2.80
Sodium	0.67	0.83	0.71
Zinc	0.79	0.77	0.70
Arsenic	--	0.011	0.009
Turbidity (APHA units)	1.30	3.10	2.20
Total solids	1,010.00	976.00	1,000.00
Suspended solids	0.60	0.30	0.20
Total organic carbon	--	0.45	6.40
Chloride	1.00	1.00	2.00
Fluoride	1.40	1.10	1.20
C.O.D.	18.00	18.00	20.00
Hardness	550.00	589.00	564.00

Units expressed in mg/l unless noted otherwise.

TABLE 3-C. SAMPLE STATION 0050, BELOW GLORY HOLE

Analysis	December 8, 1975
pH	3.30
Acidity	50.00
Alkalinity	0.00
Iron (total)	0.63
Iron (ferrous)	0.05
Specific conductance (uMhos)	280.00
Sulfate (as SO_4)	61.00
Aluminum	2.50
Cadmium	0.002
Calcium	3.10
Chromium (hexavalent)	0.01
Chromium (total)	0.01
Copper	0.01
Cyanide	0.01
Lead	0.05
Magnesium	2.60
Manganese	0.42
Mercury	ND
Potassium	0.89
Sodium	0.54
Zinc	0.10
Arsenic	0.002
Turbidity (APHA units)	1.00
Total solids	94.00
Suspended solids	0.20
Total organic carbon	0.40
Chloride	2.00
Fluoride	0.20
C.O.D.	2.10
Hardness	15.00

Units expressed in mg/l unless noted otherwise.

TABLE 6-C. SAMPLE STATION 000F, GLORY HOLE

Analysis	May 15, 1975	May 3, 1976
pH	3.10	3.40
Acidity	110.00	89.00
Alkalinity	0.00	0.00
Iron (total)	12.00	1.90
Iron (ferrous)	4.70	0.86
Specific conductance (uMhos)	640.00	440.00
Sulfate (as SO_4)	255.00	156.00
Aluminum	13.00	10.00
Cadmium	--	0.007
Calcium	28.00	17.00
Chromium (hexavalent)	0.01	0.01
Chromium (total)	0.01	0.01
Copper	0.01	0.05
Cyanide	--	0.03
Lead	0.05	0.05
Magnesium	12.00	9.70
Manganese	1.90	1.60
Mercury	--	0.001
Potassium	1.80	1.40
Sodium	0.50	0.53
Zinc	0.31	0.25
Arsenic	--	0.003
Turbidity (APHA units)	2.60	0.55
Total solids	760.00	365.00
Suspended solids	0.20	6.10
Total organic carbon	--	3.90
Chloride	7.00	9.00
Fluoride	2.00	1.10
C.O.D.	4.10	5.00
Hardness	206.00	145.00

Units expressed in mg/l unless noted otherwise.

TABLE 5-C. SAMPLE STATION D001, STREAM FROM GOB FIRE

Analysis	May 3, 1976
pH	2.00
Acidity	4,800.00
Alkalinity	0.00
Iron (total)	2,200.00
Iron (ferrous)	2,200.00
Specific conductance (uMhos)	7,000.00
Sulfate (as SO_4)	5,800.00
Aluminum	250.00
Cadmium	0.135
Calcium	29.00
Chromium (hexavalent)	0.01
Chromium (total)	0.12
Copper	0.11
Cyanide	0.01
Lead	0.05
Magnesium	120.00
Manganese	2.90
Mercury	0.003
Potassium	82.00
Sodium	35.00
Zinc	2.00
Arsenic	0.379
Turbidity (APHA units)	8.10
Total solids	10,000.00
Suspended solids	5.80
Total organic carbon	48.80
Chloride	39.00
Fluoride	6.50
C.O.D.	453.00
Hardness	5,930.00

Units expressed in mg/l unless noted otherwise.

TABLE 6-C. SAMPLE STATION 0000, PENDERGAST

Analysis	May 13, 1975	December 8, 1975	May 3, 1976
pH	2.70	2.50	2.60
Acidity	866.00	780.00	952.00
Alkalinity	0.00	0.00	0.00
Iron (total)	158.00	160.00	200.00
Iron (ferrous)	42.00	55.00	65.00
Specific conductance (uMhos)	2,060.00	1,780.00	1,860.00
Sulfate (as SO_4)	1,225.00	1,170.00	1,290.00
Aluminum	54.00	49.00	60.00
Cadmium	--	0.002	0.009
Calcium	196.00	59.00	89.00
Chromium (hexavalent)	0.01	0.01	0.01
Chromium (total)	0.06	0.03	0.05
Copper	0.30	0.11	0.25
Cyanide	--	0.01	0.01
Lead	0.02	0.05	0.05
Magnesium	34.00	36.00	43.00
Manganese	1.60	1.60	1.60
Mercury	--	ND	0.001
Potassium	1.70	1.20	1.60
Sodium	0.77	0.73	0.61
Zinc	4.20	3.40	3.30
Arsenic	--	0.005	0.003
Turbidity (APHA units)	1.20	5.10	4.00
Total solids	1,150.00	1,670.00	1,860.00
Suspended solids	6.00	0.50	0.60
Total organic carbon	--	0.40	2.70
Chloride	15.00	5.00	8.00
Fluoride	1.50	1.10	1.40
C.O.D.	6.20	18.00	13.00
Hardness	1,220.00	858.00	1,100.00

Units expressed in mg/l unless noted otherwise.

TABLE 7-C. SAMPLE STATION 000V, ARNOLD STRIP

Analysis	December 8, 1975
pH	2.90
Acidity	80.00
Alkalinity	0.00
Iron (total)	0.48
Iron (ferrous)	.10
Specific conductance (uMhos)	390.00
Sulfate (as SO4)	92.00
Aluminum	3.30
Cadmium	0.002
Calcium	6.90
Chromium (hexavalent)	0.01
Chromium (total)	0.01
Copper	0.01
Cyanide	0.01
Lead	.05
Magnesium	3.70
Manganese	0.38
Mercury	ND
Potassium	1.40
Sodium	0.33
Zinc	0.12
Arsenic	0.001
Turbidity (APHA units)	1.00
Total solids	128.00
Suspended solids	0.20
Total organic carbon	0.50
Chloride	2.00
Fluoride	0.25
C.O.D.	4.50
Hardness	53.00

Units expressed in mg/l unless noted otherwise.

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SHORT CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION ID: LIMA MINE

DATE	INPUT	FLOW CMD	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	LIMA MINE	0.523	2.5	2.6	1350.	450.	339.	0.	0.	62.0	46.7	0.5	0.4	550.	414.	44.00	33.2	0.66	0.5
[illegible]	LIMA MINE	0.867	2.5	2.7	1290.	426.	529.	0.	0.	59.0	73.6	1.3	1.6	550.	687.	42.00	52.4	0.69	0.9
[illegible]	LIMA MINE	0.855	2.6	2.8	1040.	336.	411.	0.	0.	39.0	48.0	0.6	0.9	445.	548.	30.00	36.9	0.55	0.7
[illegible]	LIMA MINE	0.867	2.8	2.5	1140.	307.	465.	0.	0.	47.0	58.6	1.4	1.7	530.	661.	35.00	43.7	0.60	0.7
[illegible]	LIMA MINE	0.625	2.5	2.6	1050.	456.	411.	0.	0.	59.0	53.1	1.1	1.0	575.	518.	41.00	36.9	0.75	0.7
[illegible]	LIMA MINE	0.740	2.7	2.6	1160.	425.	458.	0.	0.	58.0	62.4	3.1	3.3	530.	571.	41.00	44.1	0.71	0.8
[illegible]	LIMA MINE	0.471	2.6	2.5	1290.	516.	348.	0.	0.	64.0	43.4	1.2	0.8	635.	430.	49.00	33.2	0.97	0.6
[illegible]	LIMA MINE	0.460	2.6	2.6	1320.	525.	348.	0.	0.	70.0	46.4	1.9	1.3	650.	431.	52.00	34.5	0.87	0.5
[illegible]	LIMA MINE	0.285	2.6	2.5	1550.	470.	275.	0.	0.	72.0	29.6	1.7	0.7	700.	286.	55.00	22.6	1.08	0.4
[illegible]	LIMA MINE	0.267	2.5	2.5	1280.	642.	239.	0.	0.	82.0	31.5	9.5	3.6	720.	277.	56.00	21.5	0.95	0.3
[illegible]	LIMA MINE	0.255	2.7	2.5	960.	440.	160.	0.	0.	68.0	24.8	13.0	4.7	615.	224.	45.00	16.4	0.77	0.3
[illegible]	LIMA MINE	0.260	2.6	2.4	1020.	606.	227.	0.	0.	80.0	29.9	4.6	1.7	710.	266.	53.00	19.8	1.00	0.4
[illegible]	LIMA MINE	0.226	2.7	2.6	1420.	674.	218.	0.	0.	100.0	32.3	31.0	10.0	762.	246.	60.00	19.4	1.20	0.4
[illegible]	LIMA MINE	0.274	2.6	2.5	1350.	716.	221.	0.	0.	105.0	32.4	29.0	8.9	875.	270.	63.00	19.4	1.47	0.4
[illegible]	LIMA MINE	2.066	2.6	2.6	1250.	547.	1776.	0.	0.	99.0	264.8	33.0	88.2	670.	1792.	46.00	133.9	0.85	2.3
[illegible]	LIMA MINE	2.859	2.7	2.6	1020.	440.	1799.	0.	0.	42.0	171.7	0.5	2.0	495.	2024.	27.00	110.4	0.60	2.5
[illegible]	LIMA MINE	4.910	2.7	2.8	865.	282.	1996.	0.	0.	27.0	190.9	0.2	1.1	315.	2213.	19.00	134.3	0.51	3.6
[illegible]	LIMA MINE	1.089	2.7	2.7	1225.	392.	578.	0.	0.	52.0	75.6	1.2	1.7	498.	724.	36.00	52.3	0.60	1.2
[illegible]	LIMA MINE	0.510	2.6	2.7	1210.	665.	475.	0.	0.	72.0	52.8	2.5	1.8	625.	454.	45.00	33.0	0.80	0.6
[illegible]	LIMA MINE	0.826	2.7	2.7	1180.	460.	547.	0.	0.	60.0	71.3	10.0	11.9	600.	713.	40.00	47.6	0.60	0.8
[illegible]	LIMA MINE	1.089	2.7	2.6	1200.	655.	952.	0.	0.	64.0	93.0	1.0	1.5	621.	900.	45.00	65.4	0.79	1.1
[illegible]	LIMA MINE	0.566	2.7	2.5	1480.	606.	556.	0.	0.	71.0	57.7	2.8	1.6	735.	597.	52.00	42.2	0.82	0.7
[illegible]	LIMA MINE	0.695	2.7	2.6	1170.	479.	428.	0.	0.	57.0	56.9	4.6	4.6	670.	669.	44.00	43.9	0.76	0.7
[illegible]	LIMA MINE	1.474	2.5	2.7	[illegible]	589.	1369.	0.	0.	66.0	153.4	6.1	14.2	655.	1511.	47.00	109.2	0.80	1.9
[illegible]	LIMA MINE	0.765	2.6	2.5	[illegible]	680.	749.	0.	0.	70.0	77.1	1.6	1.8	740.	826.	51.00	56.7	0.89	1.0
[illegible]	LIMA MINE	0.629	2.8	2.5	1500.	696.	655.	0.	0.	75.0	67.9	4.5	4.1	775.	702.	55.00	49.8	0.96	0.9
[illegible]	LIMA MINE	0.510	2.7	2.6	1280.	659.	484.	0.	0.	70.0	51.4	4.4	3.2	700.	530.	53.00	36.7	0.87	0.6
[illegible]	LIMA MINE	0.765	2.8	2.7	1210.	500.	550.	0.	0.	64.7	70.5	8.0	8.8	635.	699.	46.00	50.6	0.79	0.9
[illegible]	LIMA MINE	0.695	2.6	2.5	1280.	677.	676.	0.	0.	76.0	75.9	3.0	3.0	742.	741.	53.00	52.9	0.90	0.9
[illegible]	LIMA MINE	0.695	2.7	2.5	1370.	667.	596.	0.	0.	78.0	77.9	4.9	4.9	720.	719.	54.00	53.9	0.89	1.0
[illegible]	LIMA MINE	0.906	2.8	2.5	1550.	650.	846.	0.	0.	72.0	93.7	8.0	10.4	675.	879.	50.00	65.1	0.89	1.2
[illegible]	LIMA MINE	2.209	2.8	2.7	1190.	528.	1679.	0.	0.	65.0	206.7	3.2	10.2	635.	2020.	45.00	143.1	0.80	2.5
[illegible]	LIMA MINE	1.291	2.6	2.6	1310.	702.	1305.	0.	0.	78.0	145.0	5.4	10.0	710.	1320.	52.00	97.0	0.85	1.6
[illegible]	LIMA MINE	2.209	2.7	2.8	1500.	458.	1457.	0.	0.	60.0	190.8	0.4	1.3	570.	1813.	38.00	120.9	0.67	2.3
[illegible]	LIMA MINE	4.010	2.7	2.6	1190.	576.	3314.	0.	0.	73.0	415.7	1.9	11.0	645.	3724.	38.00	219.6	1.00	5.8
[illegible]	LIMA MINE	1.400	2.8	2.6	1320.	652.	1274.	0.	0.	88.0	171.6	5.0	10.1	775.	1562.	46.00	92.7	1.19	2.2
[illegible]	LIMA MINE	1.189	2.9	2.5	1360.	662.	1099.	0.	0.	90.0	154.1	2.6	4.5	780.	1336.	49.00	83.2	1.20	2.1
[illegible]	LIMA MINE	3.738	2.6	3.0	885.	267.	1425.	0.	0.	37.0	199.2	1.7	9.2	290.	1561.	35.00	187.6	0.53	2.8
[illegible]	LIMA MINE	1.756	2.7	2.7	1180.	472.	1138.	0.	0.	72.0	173.0	4.9	12.1	620.	1595.	40.00	100.0	1.08	2.5
[illegible]	LIMA MINE	1.400	2.7	2.7	1230.	557.	1087.	0.	0.	73.0	147.2	1.1	2.0	625.	1280.	44.00	88.7	1.10	2.0

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION 2317 LONG MINE

DATE	IDENT	FLOW CMM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERR) MG/L	IRON(FERR) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	LONG MINE	4.996	2.7	2.8	750.	295.	2077.	0.	0.	47.0	332.6	1.4	9.9	425.	2472.	21.00	149.2	1.00	7.1
[illegible]	LONG MINE	2.875	2.9	2.7	885.	406.	1649.	0.	0.	68.0	281.5	1.2	5.0	510.	2111.	33.00	136.6	1.60	6.6
[illegible]	LONG MINE	1.400	2.9	2.7	1080.	510.	1028.	0.	0.	77.0	155.2	4.3	8.7	625.	1260.	42.00	84.7	1.10	2.2
[illegible]	LONG MINE	0.826	2.9	2.6	1150.	586.	696.	0.	0.	80.0	95.1	2.4	2.9	760.	904.	46.00	54.7	1.30	1.5
[illegible]	LONG MINE	2.486	2.7	2.6	1040.	458.	1625.	0.	0.	61.0	216.6	1.3	4.6	585.	2095.	31.00	110.3	1.00	3.6
[illegible]	LONG MINE	4.996	2.7	2.7	960.	356.	2543.	0.	0.	43.0	304.2	1.2	8.5	425.	3007.	31.00	219.3	0.74	5.2
[illegible]	LONG MINE	1.389	2.6	2.6	1080.	468.	897.	0.	0.	63.0	107.9	1.5	2.6	485.	1026.	42.00	66.5	1.20	2.1
[illegible]	LONG MINE	4.333	2.5	2.8	970.	742.	2134.	0.	0.	42.0	262.0	0.9	5.6	560.	3494.	31.00	187.2	1.00	11.9
[illegible]	LONG MINE	1.209	2.6	2.7	1040.	482.	825.	0.	0.	72.0	123.3	6.3	10.6	690.	1162.	45.00	77.6	1.40	2.4
[illegible]	LONG MINE	0.765	2.6	2.6	1055.	562.	619.	0.	0.	73.0	80.4	7.2	7.9	700.	771.	52.00	57.3	1.60	1.8
[illegible]	LONG MINE	1.189	2.7	2.8	870.	380.	651.	0.	0.	52.0	89.1	1.4	2.4	470.	805.	35.00	58.9	1.20	2.1
[illegible]	LONG MINE	0.826	2.7	2.9	960.	484.	552.	0.	0.	66.0	78.5	11.0	13.1	595.	690.	43.00	51.1	1.30	1.6

AVERAGES FOR 12 SAMPLINGS.

FLOW CMM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERR) MG/L	IRON(FERR) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
1.425	2.7	2.6	1172.	457.	936.	0.	0.	58.7	128.2	3.5	7.7	555.	1137.	36.00	75.6	0.94	2.0

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SHORT CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION: 3302 LIMA MINE

DATE	IDENT	FLOW CMM	PH FIELD	LAB	SPEC COND	ACIDITY MG/L	KG/D	ALKALINITY MG/L	KG/D	IRON(TOTAL) MG/L	KG/D	IRON(FERR) MG/L	KG/D	SULFATE MG/L	KG/D	ALUMINUM MG/L	KG/D	MANGANESE MG/L	KG/D
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	0.219	2.5	2.6	2950.	1500.	35.	0.	0.	510.0	0.3	120.0	3.6	1560.	36.	76.00	2.2	7.00	0.2
[illegible]	LIMA MINE	0.757	2.7	2.6	1020.	562.	122.	0.	0.	37.0	8.7	4.0	1.1	625.	45.	30.00	6.3	2.40	0.5
[illegible]	LIMA MINE	0.567	2.7	2.7	1070.	502.	371.	0.	0.	28.0	22.9	0.1	0.1	470.	335.	34.00	49.6	1.50	1.2
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	2.424	2.9	2.8	1500.	446.	306.	0.	0.	67.0	47.0	0.5	0.3	635.	435.	61.00	38.0	2.80	1.9
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	0.286	3.0	2.7	1240.	507.	207.	0.	0.	55.0	27.5	0.6	0.2	626.	255.	47.00	19.2	3.50	1.4
[illegible]	LIMA MINE	DRY																	
[illegible]	LIMA MINE	0.157	2.6	2.6	1110.	497.	100.	0.	0.	52.0	11.3	1.0	0.4	650.	137.	46.00	10.0	3.00	0.8
[illegible]	LIMA MINE	DRY																	

AVERAGES FOR 28 SAMPLINGS:

FLOW CMM	PH FIELD	LAB	SPEC COND	ACIDITY MG/L	KG/D	ALKALINITY MG/L	KG/D	IRON(TOTAL) MG/L	KG/D	IRON(FERR) MG/L	KG/D	SULFATE MG/L	KG/D	ALUMINUM MG/L	KG/D	MANGANESE MG/L	KG/D
0.059	2.7	2.7	1290.	459.	25.	0.	0.	49.0	4.1	2.2	0.2	543.	46.	567.0	74.2	12.27	1.2

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK—LAUREL RUN
WATER SAMPLING DATA

LOCATION CODE SNOWY CREEK

DATE	STAT	FLOW GPM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

AVERAGES FOR 25 SAMPLINGS—

FLOW GPM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION 0014 SNOWY CREEK

DATE	EVENT	FLOW GPM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	GRAB SMPL	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	SNOWY CREEK	GRAB SMPL	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	SNOWY CREEK	GRAB SMPL	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	SNOWY CREEK	GRAB SMPL	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	SNOWY CREEK	GRAB SMPL	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	SNOWY CREEK	GRAB SMPL	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	SNOWY CREEK	GRAB SMPL	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	SNOWY CREEK	GRAB SMPL	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	SNOWY CREEK	GRAB SMPL	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	SNOWY CREEK	GRAB SMPL	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	SNOWY CREEK	GRAB SMPL	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	SNOWY CREEK	GRAB SMPL	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	SNOWY CREEK	GRAB SMPL	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	
[illegible]	SNOWY CREEK	GRAB SMPL	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]	

AVERAGES FOR 19 SAMPLINGS-

FLOW GPM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION 0025 SNOWY CREEK

DATE	IDENT	FLOW CFM	pH FIELD	pH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

AVERAGES FOR 25 SAMPLINGS.

FLOW CFM	pH FIELD	pH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION [illegible] SNOWY CREEK

		FLOW	PH		SPEC	ACIDITY		ALKALINITY		IRON(TOTAL)		IRON(FERR)		SULFATE		ALUMINUM		MANGANESE	
DATE	IDENT	CMM	FIELD	LAB	COND	MG/L	KG/D	MG/L	KG/D	MG/L	KG/D	MG/L	KG/D	MG/L	KG/D	MG/L	KG/D	MG/L	KG/D
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	FROZEN																	
[illegible]	SNOWY CREEK	FROZEN																	
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

AVERAGES FOR [illegible] SAMPLINGS-

FLOW	PH		SPEC	ACIDITY		ALKALINITY		IRON(TOTAL)		IRON(FERR)		SULFATE		ALUMINUM		MANGANESE	
CMM	FIELD	LAB	COND	MG/L	KG/D	MG/L	KG/D	MG/L	KG/D	MG/L	KG/D	MG/L	KG/D	MG/L	KG/D	MG/L	KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION SITE: SNOWY CREEK

DATE	STREAM	FLOW CFS	pH FIELD	pH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

AVERAGES FOR 26 SAMPLINGS.

FLOW CFS	pH FIELD	pH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
[illegible] CREEK-[illegible] RUN
WATER SAMPLING DATA

LOCATION [illegible] [illegible] CREEK

DATE	IDENT	FLOW [illegible]	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

AVERAGES FOR 26 SAMPLINGS-

FLOW [illegible]	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
[illegible] CREEK-LAUREL RUN
AFTER SAMPLING DATA

LOCATION [illegible] SLIME HOLE

DATE	[illegible]	FLOW [illegible]	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	SLIME HOLE	[illegible]	2.7	3.3	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SLIME HOLE	[illegible]	3.0	2.8	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SLIME HOLE	[illegible]	2.8	2.8	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SLIME HOLE	[illegible]	2.8	2.7	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SLIME HOLE	[illegible]	2.7	2.9	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SLIME HOLE	[illegible]	2.8	2.8	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SLIME HOLE	[illegible]	3.0	2.7	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SLIME HOLE	[illegible]	2.7	2.7	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SLIME HOLE	[illegible]	2.7	2.9	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SLIME HOLE	[illegible]	2.8	2.8	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SLIME HOLE	[illegible]	2.7	2.9	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SLIME HOLE	[illegible]	2.8	2.9	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

AVERAGES FOR 12 SAMPLINGS-

FLOW [illegible]	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	2.7	2.9	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION DESC: LAUREL RUN

DATE	STATION	FLOW	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]																	
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

AVERAGES FOR 27 SAMPLINGS-

FLOW	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION CODE: SNOWY CREEK

DATE	LOCAT	FLOW CMM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERR) MG/L	IRON(FERR) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	FROZEN																	
[illegible]	SNOWY CREEK	FROZEN																	
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

AVERAGES FOR 25 SAMPLINGS:

FLOW CMM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERR) MG/L	IRON(FERR) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	5.7	6.5	[illegible]	4.	3.	[illegible]	[illegible]	0.7	0.5	0.2	0.2	[illegible]	[illegible]	0.36	[illegible]	0.29	0.2

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION CODE: SNOWY CREEK

DATE	IDENT	FLOW CMS	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]																	
[illegible]	SNOWY CREEK	[illegible]																	
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	SNOWY CREEK	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

AVERAGES FOR 23 SAMPLINGS-

FLOW CMS	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
TYGART CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION CODE: LAUREL RUN

DATE	IDENT	FLOW CMM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	FROZEN																	
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	LAUREL RUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

AVERAGES FOR 13 SAMPLINGS.

FLOW CMM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
[illegible] CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION CODE [illegible]

DATE	IDENT	FLOW GPM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERR) MG/L	IRON(FERR) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]																	
[illegible]	[illegible]	[illegible]																	
[illegible]	[illegible]	[illegible]																	
[illegible]	[illegible]	[illegible]																	
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[illegible]	[illegible]	[illegible]																	
[illegible]	[illegible]	[illegible]																	
[illegible]	[illegible]	[illegible]																	

AVERAGES FOR [illegible] SAMPLINGS.

FLOW GPM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERR) MG/L	IRON(FERR) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
0.000	0.0	0.0	0.	0.	0.	0.	0.	0.0	0.0	0.0	0.0	0.	0.	0.00	0.0	0.00	0.0

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION [illegible] GLORY HOLE

DATE	[illegible]	FLOW GPM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	GLORY HOLE	1.574	2.7	3.3	766.	159	301.	0.	0.	20.0	43.6	11.0	24.0	290.	632.	12.00	26.2	1.30	2.8
[illegible]	GLORY HOLE	DRY																	
[illegible]	GLORY HOLE	0.758	2.8	3.1	660.	[illegible]	147.	0.	0.	10.0	19.6	11.0	12.0	260.	290.	12.00	13.1	1.30	1.4
[illegible]	GLORY HOLE	0.758	2.7	3.0	645.	133.	145.	0.	0.	10.0	19.6	12.0	13.1	272.	297.	12.00	13.1	1.30	1.4
[illegible]	GLORY HOLE	1.605	2.7	3.0	620.	150.	296.	0.	0.	17.0	40.3	6.7	10.3	250.	555.	13.00	30.6	1.30	3.3
[illegible]	GLORY HOLE	0.758	3.2	3.1	585.	136.	144.	0.	0.	15.0	15.6	6.0	6.3	244.	266.	13.00	14.2	1.20	1.3
[illegible]	GLORY HOLE	0.059	3.4	3.2	475.	98.	1.	0.	0.	3.3	0.1	2.6	0.1	172.	1.	11.00	0.3	1.40	0.0
[illegible]	GLORY HOLE	DRY																	
[illegible]	GLORY HOLE	0.294	3.0	3.4	445.	85.	2.	0.	0.	1.9	0.7	0.9	0.3	156.	4.	10.00	0.3	1.60	0.0

AVERAGES FOR [illegible] SAMPLINGS:

FLOW GPM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
0.829	2.8	3.3	594.	130.	142.	0.	0.	10.7	17.8	13.7	12.4	255.	263.	12.00	27.8	1.40	3.1

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION IDENT ARNOLD MINE

DATE	IDENT	FLOW CFM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERR) MG/L	IRON(FERR) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
031475	ARNOLD MINE	0.0779	3.0	3.0	790.	49.	2.	0.	0.	1.3	0.0	0.1	0.0	155.	4.	6.60	0.2	0.46	0.0
052075	ARNOLD MINE	0.1756	2.7	3.1	670.	120.	20.	0.	0.	1.6	0.2	0.1	0.0	180.	30.	8.50	1.4	0.69	0.1
061175	ARNOLD MINE	0.0229	3.0	3.0	840.	136.	6.	0.	0.	1.9	0.1	0.1	0.0	225.	9.	14.00	0.6	0.89	0.0
062475	ARNOLD MINE	0.0274	2.6	2.9	734.	167.	9.	0.	0.	2.4	0.1	0.1	0.0	245.	8.	15.00	0.5	0.98	0.0
070875	ARNOLD MINE	0.0203	2.6	2.8	765.	177.	7.	0.	0.	2.9	0.0	0.1	0.0	256.	7.	20.00	0.1	1.27	0.0
072175	ARNOLD MINE	DRY																	
080475	ARNOLD MINE	DRY																	
081875	ARNOLD MINE	0.0576	2.7	2.9	640.	120.	17.	0.	0.	1.4	0.2	0.2	0.0	166.	18.	8.00	0.9	0.87	0.1
082575	ARNOLD MINE	0.0597	2.6	2.9	660.	155.	19.	0.	0.	2.0	0.1	0.1	0.0	205.	19.	11.00	0.8	0.88	0.1
090275	ARNOLD MINE	0.1183	2.7	2.9	640.	136.	36.	0.	0.	1.5	0.4	0.1	0.0	180.	46.	8.27	2.2	0.69	0.2
091675	ARNOLD MINE	0.0862	3.0	2.9	780.	165.	35.	0.	0.	2.5	0.5	0.1	0.0	240.	54.	16.00	0.9	0.97	0.1
092975	ARNOLD MINE	0.0275	2.9	2.8	747.	189.	27.	0.	0.	4.1	1.4	0.1	0.0	254.	75.	15.00	1.6	0.80	0.1
101375	ARNOLD MINE	0.0197	2.7	2.8	800.	223.	6.	0.	0.	4.0	0.1	0.2	0.0	278.	7.	18.00	0.4	0.96	0.0
102775	ARNOLD MINE	0.0272	2.7	2.8	880.	237.	4.	0.	0.	3.7	0.1	0.2	0.0	298.	5.	19.00	0.3	1.00	0.0
111075	ARNOLD MINE	0.0055	3.0	3.1	920.	205.	1.	0.	0.	3.6	0.0	0.1	0.0	323.	2.	21.00	0.1	1.10	0.0
112475	ARNOLD MINE	DRY																	
120875	ARNOLD MINE	0.0107	2.5	2.7	920.	248.	2.	0.	0.	4.2	0.0	0.2	0.0	330.	3.	22.00	0.2	1.20	0.0
122275	ARNOLD MINE	0.0229	2.5	2.8	760.	196.	7.	0.	0.	2.6	0.1	0.1	0.0	226.	6.	11.00	0.5	0.73	0.0
010576	ARNOLD MINE	0.3347	2.6	3.0	500.	140.	76.	0.	0.	2.0	1.6	0.1	0.0	160.	85.	8.00	4.4	0.60	0.3
011976	ARNOLD MINE	FROZEN																	
020276	ARNOLD MINE	0.0844	2.6	3.0	790.	177.	23.	0.	0.	2.5	0.2	0.1	0.0	246.	56.	13.00	0.8	0.71	0.0
021676	ARNOLD MINE	0.1160	2.7	3.0	625.	155.	29.	0.	0.	1.9	0.4	0.1	0.2	184.	41.	11.00	2.3	0.65	0.1
022776	ARNOLD MINE	0.1367	2.7	3.1	530.	96.	49.	0.	0.	1.2	0.6	0.1	0.0	144.	72.	8.00	4.0	0.56	0.3
030176	ARNOLD MINE	0.1129	2.8	3.0	580.	90.	10.	0.	0.	1.1	0.2	0.1	0.0	172.	32.	6.10	1.1	0.62	0.1
031576	ARNOLD MINE	0.1100	2.9	3.0	650.	119.	17.	0.	0.	1.5	0.2	0.1	0.0	176.	25.	10.00	1.4	0.58	0.1
032976	ARNOLD MINE	0.1140	2.8	2.9	570.	100.	21.	0.	1.	1.2	0.3	0.1	0.0	160.	36.	7.30	1.6	0.62	0.1
041276	ARNOLD MINE	0.1776	2.6	3.1	545.	103.	17.	0.	0.	1.3	0.2	0.1	0.0	136.	20.	7.00	1.1	0.39	0.1
042676	ARNOLD MINE	0.1057	2.9	2.8	680.	171.	7.	0.	0.	2.0	0.1	0.1	0.0	204.	11.	12.00	0.6	0.63	0.0

AVERAGES FOR 28 SAMPLINGS-

FLOW CFM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERR) MG/L	IRON(FERR) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
0.0771	2.8	2.9	700.	129.	14.	0.	0.	1.7	0.2	0.1	0.0	177.	19.	12.00	1.2	0.75	0.1

WEST VIRGINIA ACID MINE DRAINAGE STUDY
[illegible]
WATER SAMPLING DATA

LOCATION CODE: [illegible]

DATE	IDENT	FLOW CMS	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
[illegible]
WATER SAMPLING DATA

LOCATION CODE [illegible]

DATE	[illegible]	FLOW CMP	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERR) MG/L	IRON(FERR) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

AVERAGES FOR 10 SAMPLINGS.

FLOW CMP	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERR) MG/L	IRON(FERR) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0.	0.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
[illegible] CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION CODE: ARNOLD STRIP

DATE	EVENT	FLOW CMM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	[illegible]																	
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	FROZEN																	
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	ARNOLD STRIP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

AVERAGES FOR [illegible] SAMPLINGS.

FLOW CMM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
[illegible]
WATER SAMPLING DATA

LOCATION [illegible] STRIP MINE

DATE	[illegible]	FLOW CMF	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	STRIP MINE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

AVERAGES FOR 28 SAMPLINGS-

FLOW CMF	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION [illegible] ARNOLD STRIP

DATE	[illegible]	FLOW CMM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	0.709	2.8	3.1	370.	85.	32.	0.	0.	0.4	0.1	0.1	0.0	76.	26.	2.30	0.6	0.30	0.1
[illegible]	ARNOLD STRIP	0.745	2.7	3.3	280.	52.	52.	0.	0.	0.2	0.1	0.1	0.0	76.	15.	1.20	0.3	0.29	0.0
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	0.206	2.7	3.3	326.	60.	18.	0.	0.	0.3	0.1	0.1	0.0	66.	19.	1.60	0.5	0.26	0.1
[illegible]	ARNOLD STRIP	FROZEN																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	1.107	3.0	3.5	182.	25.	29.	0.	0.	0.1	0.3	0.1	0.1	40.	46.	1.20	1.4	0.21	0.2
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	0.063	3.0	3.2	288.	47.	4.	0.	0.	0.3	0.0	0.1	0.0	57.	5.	1.70	0.2	0.29	0.0
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	
[illegible]	ARNOLD STRIP	DRY																	

AVERAGES FOR 26 SAMPLINGS.

FLOW CMM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
0.253	2.8	3.3	285.	47.	5.	0.	0.	0.3	0.0	0.1	0.0	58.	6.	2.41	0.6	1.21	0.1

WEST VIRGINIA ACID MINE DRAINAGE STUDY
[illegible] CREEK-LAUREL RUN
WATER SAMPLING DATA

LOCATION STSN: GRAFTON COAL

DATE	IDENT	FLOW CMS	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERRO) MG/L	IRON(FERRO) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

AVERAGES FOR 12 SAMPLINGS-

FLOW CMS	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERRO) MG/L	IRON(FERRO) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK—LAUREL RUN
WATER SAMPLING DATA

LOCATION: [illegible] GRAFTON COAL

DATE	IDENT	FLOW CFM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	GRAFTON COAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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AVERAGES FOR 16 SAMPLINGS:

FLOW CFM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
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WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK-LAUREL RUN
WATER SAMPLING DATA

SUMMARY LISTING OF ALL GRAB SAMPLE POINTS

DATE SITE IDENT	FLOW CMM	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERROUS) MG/L	IRON(FERROUS) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D

WEST VIRGINIA ACID MINE DRAINAGE STUDY
SNOWY CREEK-LAUREL RUN
WATER SAMPLING DATA

SUMMARY LISTINGS OF ALL GRAB SAMPLE POINTS

DATE	SITE	EVENT	FLOW CMS	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERRO) MG/L	IRON(FERRO) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
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WEST VIRGINIA ACID MINE DRAINAGE STUDY
SANDY CREEK-LAUREL RUN
WATER SAMPLING DATA

SUMMARY LISTING OF ALL GRAB SAMPLE POINTS

DATE SITE IDENT	FLOW CMS	PH FIELD	PH LAB	SPEC COND	ACIDITY MG/L	ACIDITY KG/D	ALKALINITY MG/L	ALKALINITY KG/D	IRON(TOTAL) MG/L	IRON(TOTAL) KG/D	IRON(FERRO) MG/L	IRON(FERRO) KG/D	SULFATE MG/L	SULFATE KG/D	ALUMINUM MG/L	ALUMINUM KG/D	MANGANESE MG/L	MANGANESE KG/D
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APPENDIX D

MOVABLE WALL BULKHEAD MINE SEAL[a]

Investigations of double bulkhead mine seals which had failed strongly suggested that some employed seals failed as a result of inability of the rigid keyed inner walls to withstand unanticipated hydraulic pressures. Self-compaction of the central clay core by forces of gravity (including horizontal lattice layering of minerals) over extended intervals of time compounded the problem and often resulted in voids at the roof that render the clay core ineffective as a sealant. Any minor leakage that bypasses the inner wall or occurs upon failure of that wall permits unrestricted water flow directly against the foreward bulkhead and also against the peripheral coal and rock surfaces. The writer is convinced that many failures of traditionally installed double bulkhead seals result from the static force design criteria employed.

The movable wall bulkhead mine seal, illustrated in Figure D-1, is similar in components to the rigid double bulkhead seal having an inner wall, a central core of clay (or other impervious material), and an outer bulkhead (Scott, Robert B. 1972. *Evaluation of Bulkhead Seals*. Office of Research and Monitoring, U.S. Environmental Protection Agency). However, the proposed mine seal continually utilizes the pressure of the head of water contained to assist in maintaining the integrity of the unit.

In principle, the inner movable wall serves as a ram dynamically driven forward by the changing or constant hydraulic head of water behind the seal. Stress and movement of the wall is transmitted through the central core of clay (or other suitable pliable plastic sealant) pressing that material firmly against all surfaces and weak areas of the center chamber. Bentonite or other swelling clays may be used in the central core area as well as for a thin layer between the inner wall and the mine floor, pillars and roof to insure the integrity and obtain initial compression throughout the core material. The force will continually maintain or improve the efficiency of the clay core for sealing the entry.

In Figure D-1, the inner movable wall is maintained in alignment by means of solid bars that pass through sleeving in the outer fixed or rigid plug. Other alignment arrangements are possible to prevent tilting. The

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[a] Reprints by permission from Edwin F. Koppe and Associates, Consulting Geologist, Harrisburg, Pennsylvania, 1976.

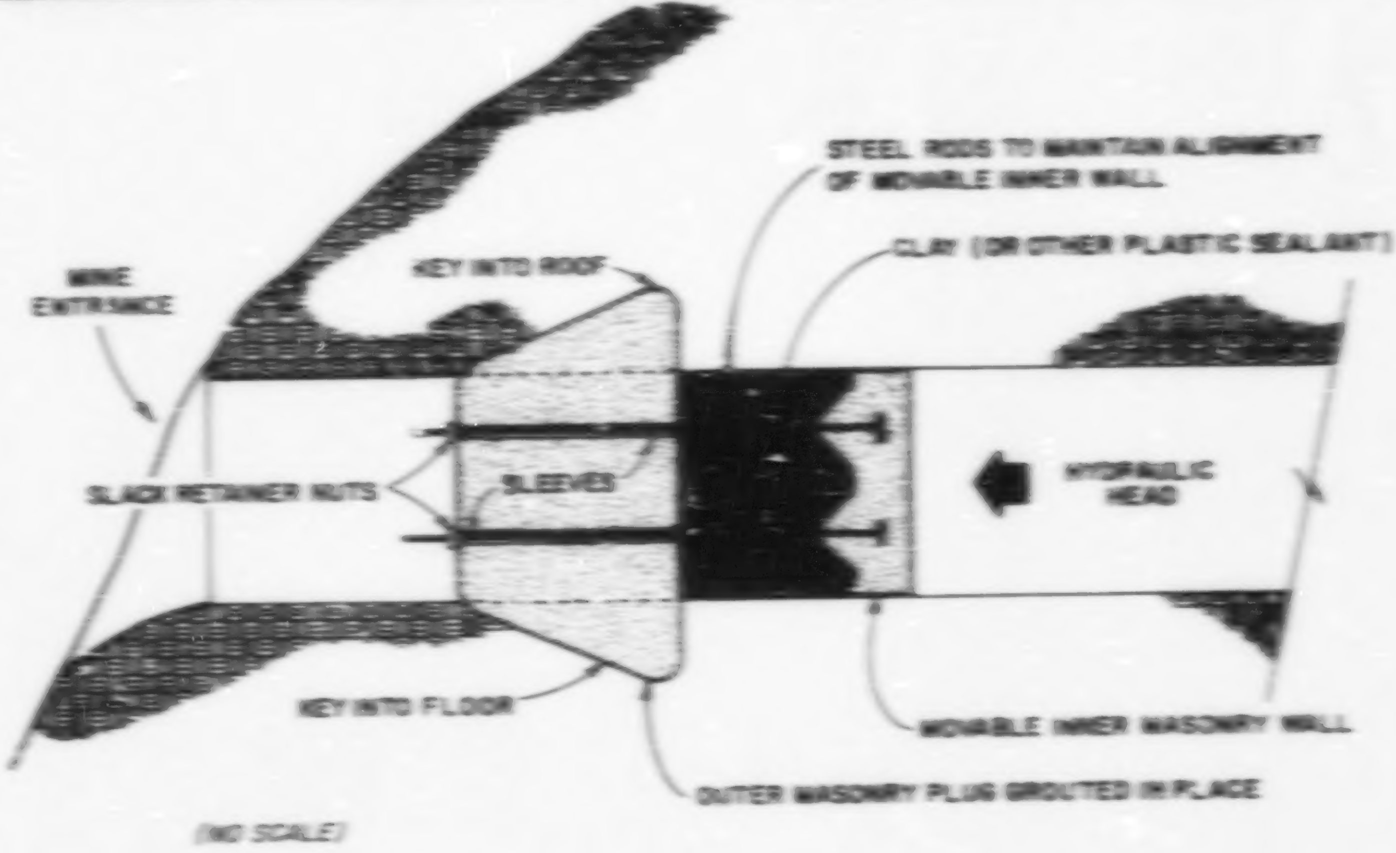
STEEL RODS TO MAINTAIN ALIGNMENT OF MOVABLE INNER WALL
MINE ENTRANCE
KEY INTO ROOF
CLAY (OR OTHER PLASTIC SEALANT)
SLACK RETAINER NUTS
SLEEVES
HYDRAULIC HEAD
KEY INTO FLOOR
MOVABLE INNER MASONRY WALL
OUTER MASONRY PLUG GROUTED IN PLACE
(NO SCALE)

Figure D-1. Movable wall bulkhead mine seal.

illustrated bar connection provides a means of monitoring movement of the inner wall. If the movable wall and bars are designed with sufficient strength, the bars may be used to draw up the wall and effect the initial compression of the core material before development of the hydraulic forces of the water behind the seal.

The outer rigid masonry plug is designed with the strength of a single bulkhead hydraulic seal for the maximum anticipated head of water. This plug should be satisfactorily keyed and grouted into place. Any other standard design may be used. The particular design is similar to one illustrated in 1928 (Zern, E.N., editor, 1928, Coal Miner's Pocketbook, 12th edition, McGraw-Hill, 1926, p.889).

GLOSSARY

adit: A nearly horizontal entrance to an underground mine.

anticline: A fold of sedimentary bedrock which dips down and away from a common ridge or axis.

backfill: Material placed back into an excavation, returning the area to a predetermined contour.

diversion ditch: Ditch constructed to control surface runoff.

gob: Mine refuse pile or other coal material removed from the coal through a cleaning process.

highwall: The deeper exposed face of strata resulting from excavation in surface mining.

lowwall: The shallower side of excavation in a surface mine cut.

mine pool: Flooded portions of abandoned deep mine workings.

mine pool level control lake: A mine pool controlled by the elevation of a surface impoundment.

outcrop: A natural exposure or position of a geologic unit at the intersection of that unit with the ground.

overburden: Soil and rock strata overlying a minable mineral.

pH: Negative logarithm to the base ten of hydrogen ion activity. pH 7 is neutral. Values above pH 7 are basic, those below pH 7.0 is acidic.

regrade: To change the contour by the use of leveling or grading equipment.

spoil: Overburden material that is removed as a result of excavating for a marketable mineral.

syncline: Fold in rocks in which the strata dip inward and downward toward the axis. Opposite of anticline.

synclinal basin: A basin having characteristics of a syncline.